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(ENGLISH EDITION)

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CONTENTS OF THE NUMBER FOR DECEMBER 1938.

CONTENTS.	Page.

CONTENTS *(continued)*	Page.

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BULLETIN
OF THE
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[625. 1 (.493) & 656. 25 (.493)]

Note
on the transfer of the electric signal box No. III at Brussels (Nord) Station.

1. — Introduction.

The work at present being carried out in order to connect the station of Brussels (Nord) with that of Brussels (Midi) calls for the raising by approximately 8 m. (26' 3") of all the installations within the Brussels (Nord) Station and for the setting up by stages of approach lines on a connecting grade extending northwards to the southern extremity of the neighbouring Schaerbeek station.

The raising of the platform level will be the occasion for a complete modification of the lay-out of the approach lines and of the installations in the vicinity. Figure 1 shows the lay-out of the tracks before the start of the works, in dotted lines, and the ultimate lay-out in full lines.

This modification of the lay-out is necessary for several reasons : it allows the number of approach lines towards Brussels (Nord) to be increased from 10 to 12; it corrects the alignment of the Antwerp and Liége main lines; it removes the present crossing of the Antwerp electrified tracks with the Namur main line. Finally, it makes it much easier to raise the formation level between the Rue des Palais and Schaerbeek Station in longitudinal sections.

A strip of land, completely outside the existing installations, is available at that point, so that it is possible to carry out the necessary work without any interference with the traffic. These various modifications necessitated the transfer of all neighbouring installations.

Amongst these installations, the electric signal box No. III, which controls all the traffic movements in and out of the Brussels Nord station, should be specially mentioned.

It was necessary to remove this signal box from its site in order to conform not only to the ultimate lay-out of the tracks, but also to the different lay-outs corresponding to a series of intermediate stages of the work in hand.

At first sight, the obvious solution would appear to be the construction of a new signal box, well outside the limits

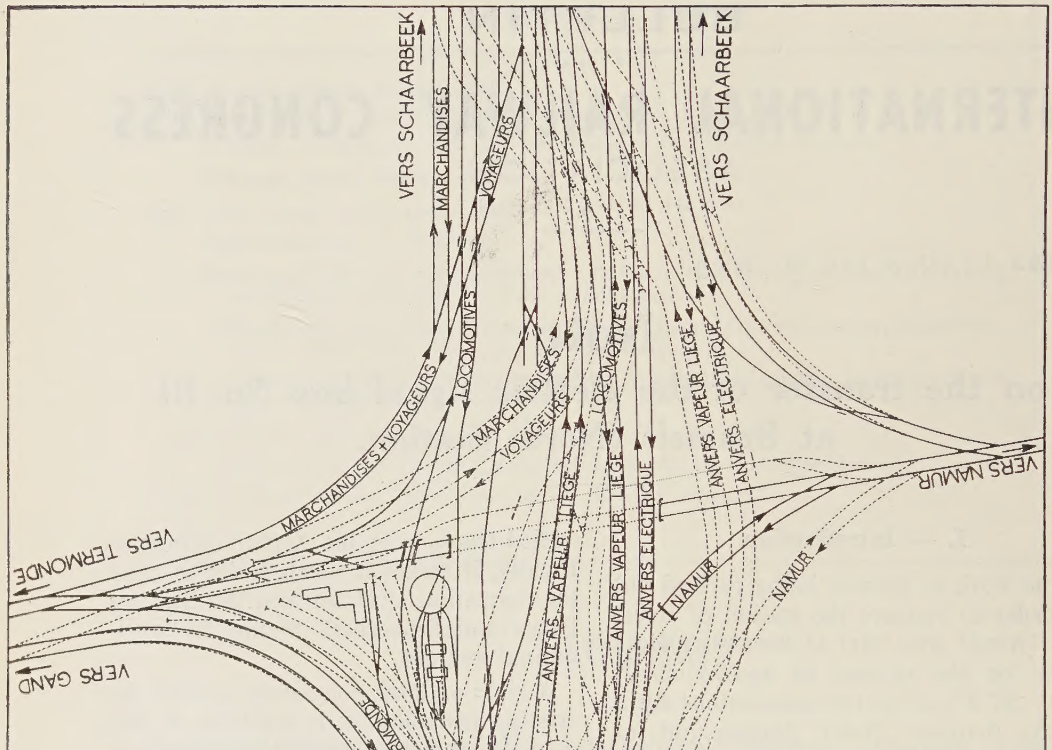

Fig. 1.

Explanation of French terms:

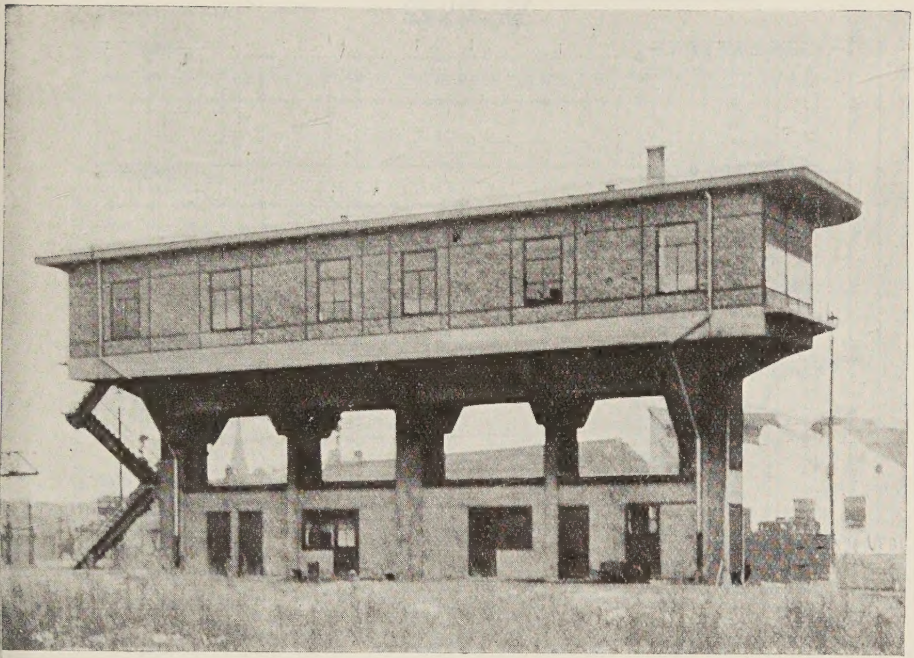

Fig. 1b.

he future installations. This solution, ever, had the drawback of being ex- sive and requiring too much time. eover, several gangs of linesmen ld have been required for many s on the installation work for the box, to the detriment of other sig- ng work also required for the con- ion of the Nord and Midi stations. over-simple solution also called, in tion, for the putting into service of ew box without the slightest interrup- of the traffic, this change-over being nore intricate on account of the very rtant area controlled from the box. e second solution considered con- l in shifting the box whilst in ser- for a distance of approximately 23 75 1/2 ft.) parallel to its longitudi- xis. This solution had the following advantages : a much lower expenditure, and a rapid execution requiring only a small number of men.

In addition the following three points were in favour of the adoption of this solution :

1. The cabin having an « all-electric » operation, it would be possible to carry out the transfer whilst maintaining the cabin in full service without any interruption, provided the neccessary additional lengths of cable were joined to those connected to the box.

2. The type of construction of the cabin, a monolithic ferro-concrete frame, was eminently suitable for such a complete transfer and, on examination, gave practically complete guarantee that during the transfer it would not be subject to any deformation apt to endanger the

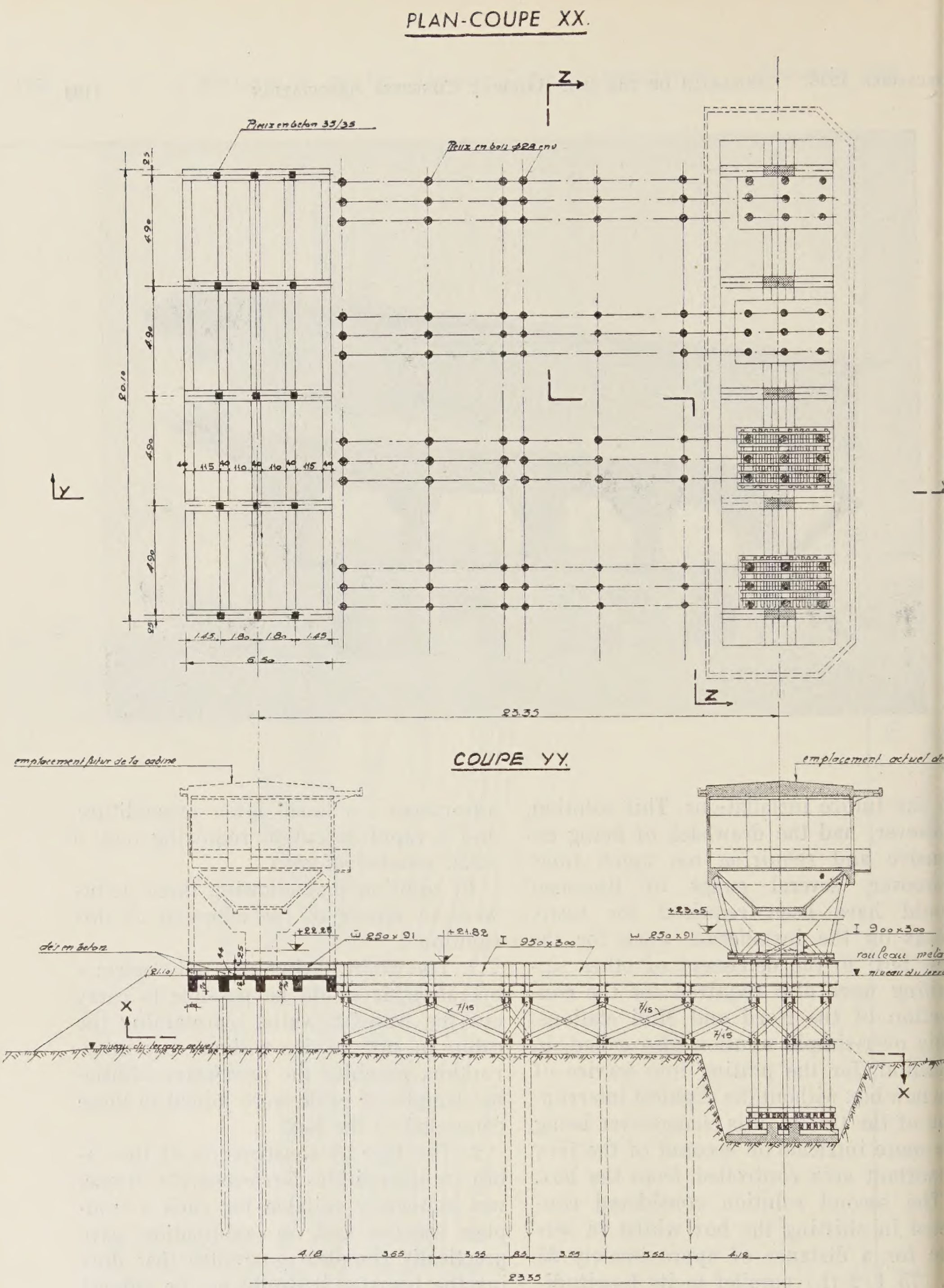

Fig. 2.

Explanation of French terms:

Dés en béton = concrete cubes. — Emplacement actuel de la cabine = present location of the signal-box. — Emplacement futur de la cabine = future location of the signal box. — Niveau du terrain futur = future ground level. — Pieux en béton = concrete piles. — Pieux en bois = wooden piles. — Plan-coupe XX (YY) = plan section along XX (YY). — Rouleau métal. = 2 3/4" diameter metal roller.

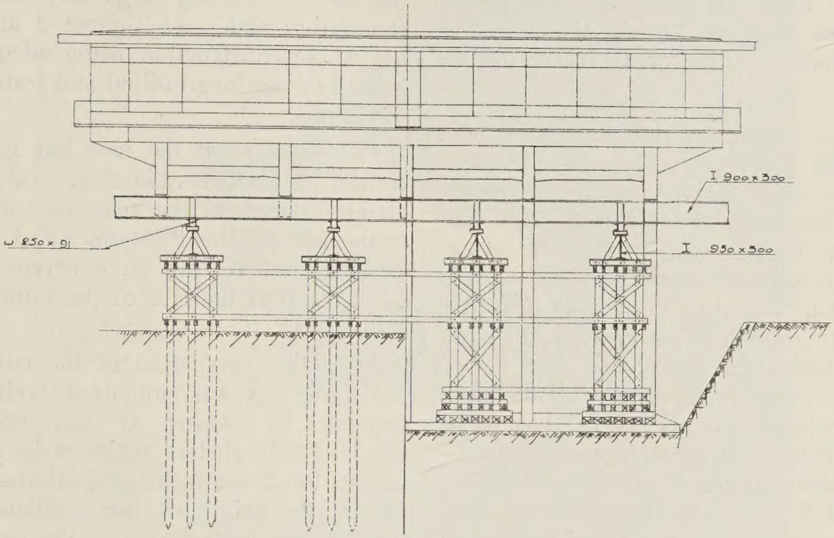

Fig. 3.

orrect operation of its many and most ıtricate signalling appliances.

3. The tracks of the line towards Ter-ıonde and Ghent, normally located be-veen the old and the new site of the gnal box, were temporarily diverted, in :cordance with the stage of the work in ınd at the time. The site was therefore ılly available for a few months, so that was possible to carry out the transfer ithout any hindrance.

The second solution was adopted, after careful examination of all matters :aring on it.

Tenders were then called for, the work ıving to be carried out according to a ogramme laid down by the Belgian Na-ınal Railways Company (S. N. C. F. B.). s a matter of fact the method submitted the S. N. C. F. B. — as an example ıen calling for tenders — appeared to e tenderers to offer the maximum economy and also the maximum safety. It was the one adopted and it gave full satisfaction.

We give below a description of the work entailed by the transfer itself as well as some details of the signalling work required in connection with this transfer.

2. — Description of the work for the transfer of signal box No. III.

The box was erected some years ago on a ferro-concrete frame carried by five double cantilevers resting on the ferro-concrete foundation bed through columns, also of ferro-concrete, having a rectangular section of 1.40 m. × 0.50 m. (4' 7" × 1' 8").

Premises for the heating installation, the coal stores, a staff room, and lavatories, had been arranged in the spaces be-

tween the columns. One of them was used to house the cable terminal boxes.

Figure 1*b* shows the signal box before the transfer, which was carried out as follows :

At the new site, a new foundation was provided consisting of a ribbed ferro-concrete slab, carried by 15 ferro-concrete piles rammed until fast. This slab is at the level to which the track formation will ultimately be raised, and will be used at a later date to provide new premises to replace those mentioned above, which had to be demolished.

Four runways were erected between the 5 columns supporting the box to be transferred, in the direction of the transfer. These runways consisted of 950-mm. (3' 1 3/8") girders supported by rows of piles on the one hand and by timber trestles on the other hand, the latter resting on the existing large ferro-concrete foundation slab (see figures 2 and 3), the whole construction being adequately braced in the longitudinal and transverse directions.

The runways at the new box location consist of smaller (250 mm. = 9 7/8") girders placed on the same axis as, and connected to, the 950-mm. (3' 1 3/8") girders, and resting on concrete cubes cast on top of the ribs of the foundation slab.

After the completion of the runways, the signal box was supported during the transfer by means of two 900-mm. (2' 11 1/2") girders which were placed in position beneath the projections of the box at the origin of the cantilevers of the ferro-concrete frame of the box.

Fig. 3*b*.

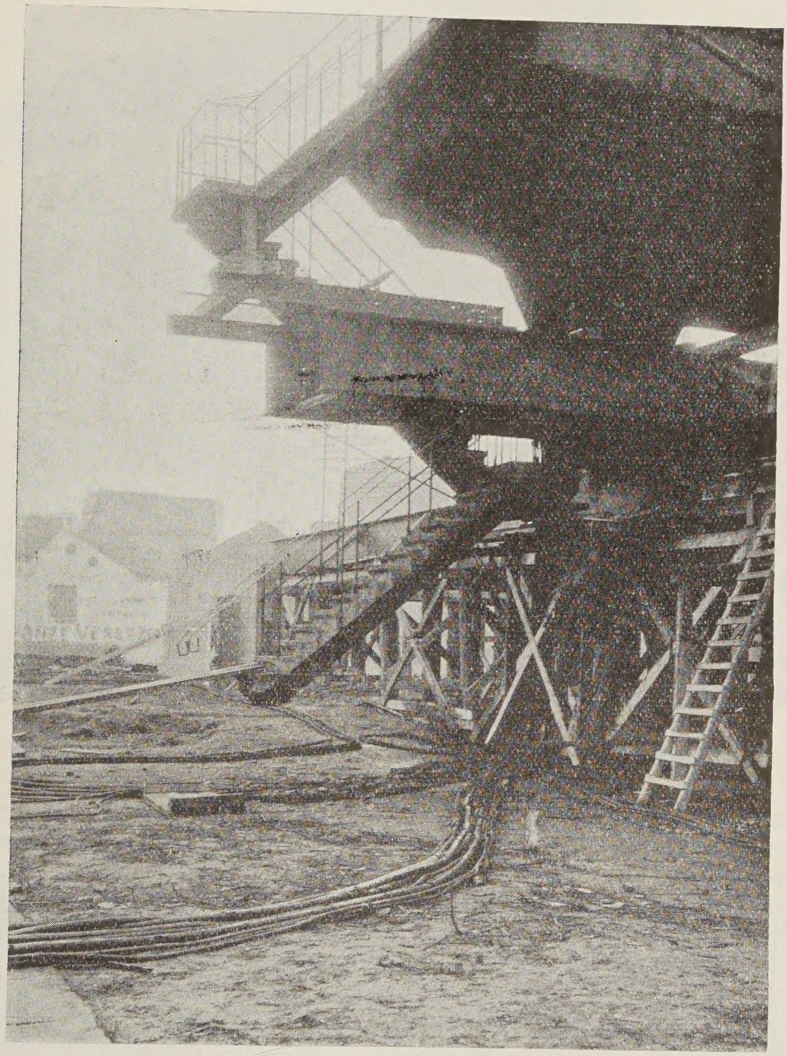

Fig. 4.

These two girders rested, by means of el rollers, having a diameter of 70 mm. 3/4"), on four movable trucks run- ıg on each of the four runways (fi- e 3*b*).

'he trucks were built up of two channel ns 250 mm. (9 7/8") high and 4.50 m. (14' 9") long, bolted together through wooden joists inserted between them. Between the channel irons were mounted wooden props staying the ends of the transverse overhang of the box and keeping in place the 900-mm. (2' 11 1/2") steel girder supporting the signal box.

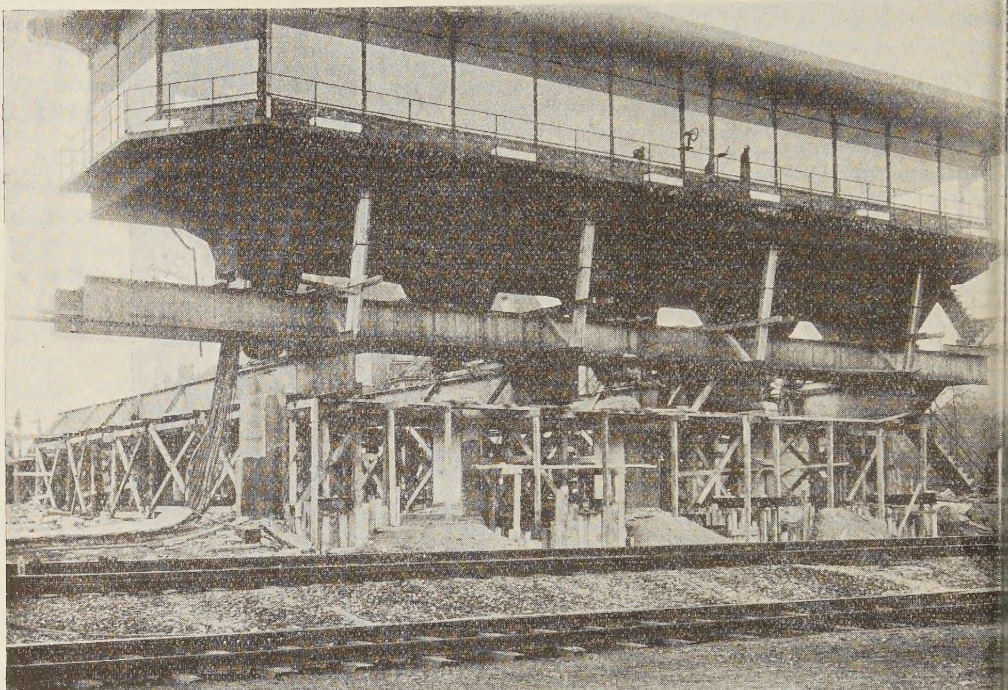

Fig. 4b.

In order to ensure an even settling and a uniform distribution of the load, lead sheets were placed between the ferro-concrete frame and the 900-mm. girders. These girders also carried, by means of steel rods, the ferro-concrete staircase giving access to the cabin, which was also kept in service throughout the transfer (fig. 4).

After having ascertained with the utmost care that the runways were perfectly level, the ferro-concrete columns supporting the signal box were cut off at the level of the movable trucks, whilst the staircase was disconnected from its base. When the signal box was completely freed from its supports, i. e. at the moment when it came to rest on its transfer seat, the settling was 6-7 mm. (1/4" to 9/32") and was scarcely noticed b the signalmen carrying out their norma duties. The box was thus completely cu off from its supports (figure *4b*).

The transfer then took place by mean of four short-stroke hydraulic jack abutting on each of the runways.

Control of the equal progress of a four trucks was possible at any time b means of graduated scales fixed to eac runway. In addition, in order to chec the level of the box during the transfe water levels, based on the principle o U-tubes, were provided in each of th four corners of the building. The maxi mum drop recorded during the transfe along the longitudinal axis of the bo

Fig. 5.

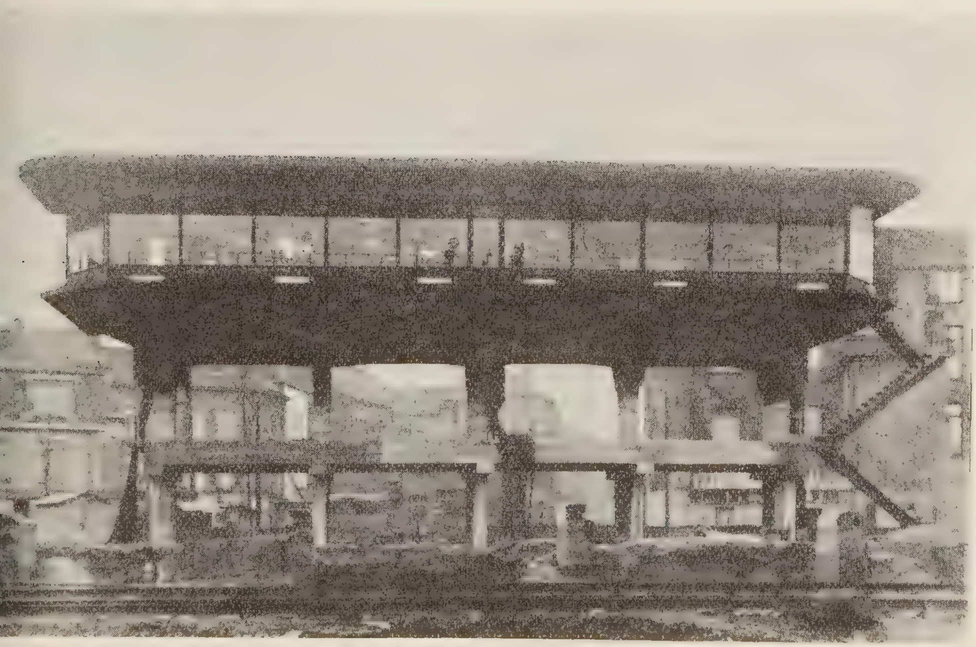

Fig 6.

did not exceed 7 mm. (9/32"), a value compatible with the good operation of the cabin installations. The mean drop amounted to approximately 3 mm. (1/8").

The work was carried out without any difficulties in 60 days, including the necessary preliminary and finishing work (fig. 5). The progress of the transfer itself varied between 2 and 6 m. (6.6 and 19.8 ft.) per day.

The weight of the part to be moved was approximately 250 tons; the average horizontal force at the jacks was ascertained to about 1/10th of this load, say 25 tons.

After arrival of the box at its ultimate location, the stumps of the ferro-concrete columns were connected to the new foundation plate. The necessary number of irons had been provided in the foundation plate, of such a height as to overlap the irons left at the bottom of the cut off columns. After this connection had been made, the trucks and transfer equipment were removed. Figure 6 shows the signal box after the transfer had been completed.

The work was skillfully carried out by Messrs. A. MONNOYER and E. FRICERO, of Brussels, under the supervision of the SECURITAS Office, also of Brussels.

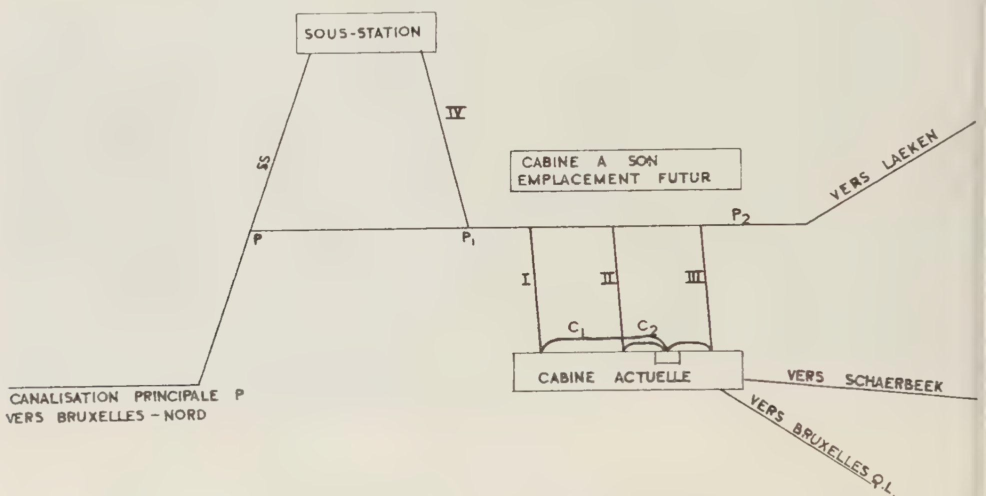

Fig. 7.

Explanation of French terms:

Cabine actuelle = signal box at its present location. — Cabine à son emplacement futur = signal box at its future location. — Canalisation principale P vers Bruxelles-Nord = main cable line P to Brussels (Nord) station. — Sous-station = sub-station. — Vers Laeken (Schaerbeek, etc...) = to Laeken, Schaerbeek, etc...

3. — Realignment of the cables.

Signal box No. III controls the electric signalling on the main lines towards GHENT and TERMONDE, on the steam and electrified lines towards SCHAERBEEK, on the running lines for rakes and locomotives between BRUSSELS (Nord), LAEKEN,

SCHAERBEEK and BRUSSELS (Quartier Léopold). Considerable work was therefore necessary on the cables both before and during the transfer of the box. Figure 7 is a diagram of the locations of the cables before starting the work; each of the cable lines shown on the sketch comprised cables for the control and operation of points, signals, treadles, track circuits, telephones, electric indication and detection, etc.

conductors, connecting the BRUSSELS (NORD) telephone exchange with LAEKEN, SCHAERBEEK and BRUSSELS-JOSAPHAT, which were interrupted at box No. III, ending in terminal boxes mounted inside a room provided between two supporting columns. Secondary cables were taken out of this room and up into the box proper by means of the three vertical ducts.

Figure 8 shows a lay-out plan, on a

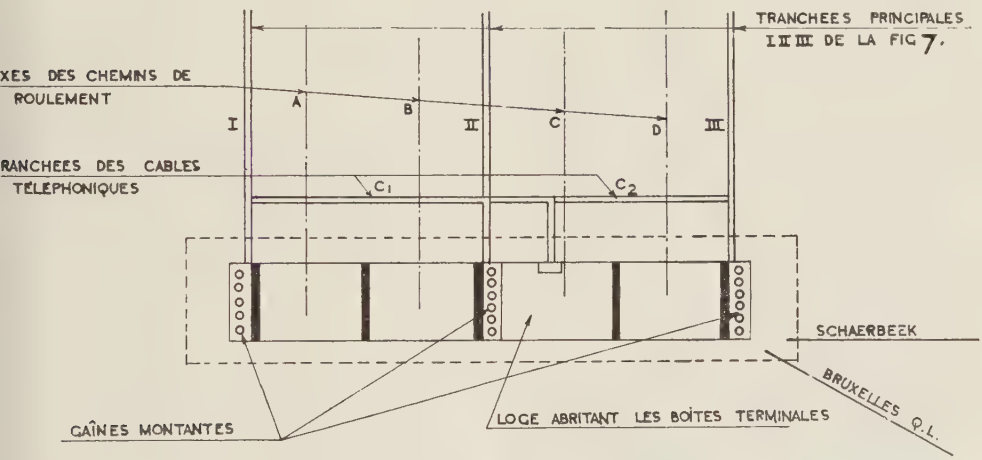

Fig. 8.

Explanation of French terms:

Axes des chemins de roulement = centre line of runways. — Gaînes montantes = vertical ducts. — Loge abritant les boîtes terminales = housing for cable terminal boxes. — Tranchées des câbles téléphoniques = telephone cable trenches. — Tranchées principales = main trenches.

The locations for the main cable lines and SS were selected taking into account the constructive work of the first age of the NORD-MIDI connecting line.

The main cable line P (figure 7) used be subdivided near the cabin in three nes I, II and III, ending in three vertil cable ducts, one along each of the ree supporting columns of the box. nese three ducts contained respectively , 36 and 40 signalling cables, 8 telepho cables with 30, 50 and 60 pairs of

larger scale, of the cable trenches in relation to the location of the signal box and the runways.

As the signal box was going to be transferred by means of runways supported on wooden piles, it was necessary:

(1) to demolish the room containing the terminal boxes;

(2) to shift the cables laid alongside the signal box in the trenches C_1 and C_2;

(3) to slightly modify the location of the cable trenches II and III, in order

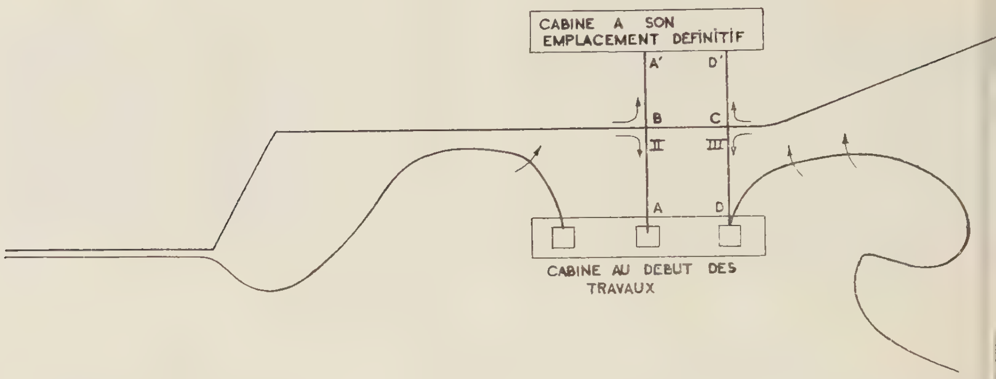

Fig. 9.

Note. — Cabine à son emplacement définitif = signal box at its ultimate location. — Cabine au début des travaux = cabin at the start of the works.

that they should not hinder the construction of the runways A, B, C, D.

Section P_1P_2 (figure 7) of the cable line was then laid half way between the old and the new locations of the box and perpendicular to the runways, so that sections AB and CD of the cable lines in trenches II and III would, after the transfer, take up the location BA', and CD' (see fig. 9).

In order to facilitate the realignment of the cables in line P, they were taken out of their trench and laid out on the ground (see fig. 9).

It was of course necessary to increase the length of the cables in the SCHAERBEEK and BRUSSELS (Q. L.) directions controlling the points, signals and other safety installations, by a distance slightl exceeding that corresponding to the trans fer of the signal box. They were also ar ranged in a loop above ground to be re moved after completion of the works The work was carefully studied, cabl by cable, in order to avoid any interfe rence with the traffic. It was, for instan ce, necessary to arrange for the exten sion of certain vital cables by night.

The demolition of the room containin the terminal boxes as well as the realign ment of the cables in trenches C_1 and C called for cable jointing, some of whic was carried out in service, i. e. witho using any auxiliary cable and witho interrupting any connections.

C. L.

[625. 143 & 625. 17]

How prolong the life of rails? [1]

Current methods of rail conservation and improved rail manufacture,

by C. B. BRONSON,

Inspecting Engineer, New York Central.

(*Railway Engineering and Maintenance.*)

Since new rail comprises only a small ›ercentage of the total rail in track, pri- nary consideration in any discussion of ·ail conservation should be given to the ›roblem of increasing the service life of ·ail that has been in the track for some ime and which has been subject to so- ne wear and deterioration. I shall, herefore, discuss first some of the as- ›ects of this broad phase of the general ›roblem of rail conservation, after vhich attention will be given to the natter of new rail.

When is rail worn out?

Let us consider first the question : Vhen is rail in such condition as to re- uire renewal? Practically all main- enance officers will accept as much ew rail for immediate installation as ney can get. Moreover, much rail hich was represented as being urgent- in need of renewal five or more years go, is still in service and carrying fas- r trains than ever before. It is not my itention to argue against the installa- on of new rail but I am inclined to be- eve that the capacity of rail steel to bsorb additional wear has often been nderestimated.

For instance, it may be contended that il is so badly « surface bent » that it beyond correction, but this is a much- used term which is used to designate a condition that does not exist. Rail may be considered too thin for safety; it may look like it had flowed too much and is, therefore, useless. Or, in addition to containing these defects, it may be corrugated and burnt and, therefore, must be removed. But the rattle of the buffers, face plates and draft gears is far less pleasant to me than the imperfections mentioned.

Driver-burnt rails.

Rail burns may occasionally have serious implications, but not as a general rule. Moreover, this troublesome condition is perennial at certain locations, such as turnouts, signals, water cranes, and stations, where the locomotives of long trains stop, and any new rail installed at such places is likely to be burnt the day following its installation. Our only recourse in this situation is to appeal to the operating department to the end that locomotives will be handled in such a manner as to avoid spinning the drivers. So far such appeals have been of but little avail in correcting the situation.

The building up of driver-burnt spots in rails by electric arc or gas welding has been advocated, but, in my opinion, this is a dangerous practice. It is true that thousands of rail ends are built up with a fair degree of success, but the application of metal in the body of the rail sets up high internal stresses, and the quick chilling of the metal produces a border structure that is highly

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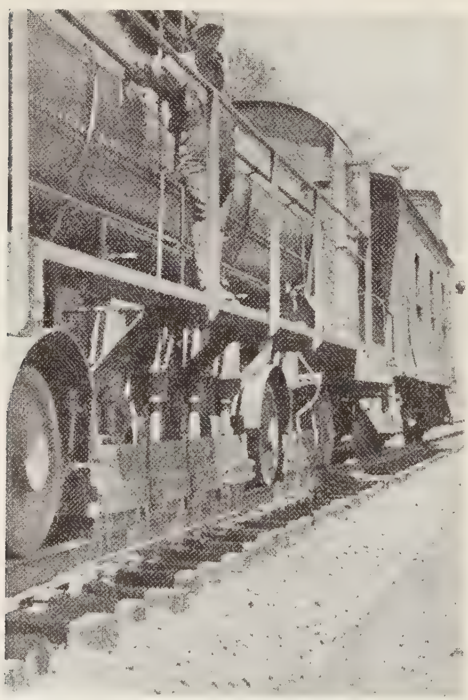
(*) Abstracted from a paper presented be- e the Metropolitan Track Supervisor's ıb, New York.

susceptible of fracture. Such welds, of which there might be three or four or even more in one rail, are potential fractures of the type that could occur suddenly. In my opinion the welding of burnt spots on rails is a practice that should not, in the interest of safety, be tolerated.

Corrugations comprise another troublesome problem that has not yet been solved. No one has yet been able to lay his finger directly on the cause of rail corrugations. An answer is no sooner presented than new developments prove it to be incorrect. Corrugations, which are generally 0.004 to 0.006 in. in depth are, of course, not dangerous and it would be difficult to show whether they have any direct effect on maintenance or its cost.



The « Scrubber » car employed on the Lehigh Valley for removing rail corrugations.

Various attempts have been made to remove corrugations by grinding, and the best device for this purpose that I have seen is the grinder or « scrubber » car (**) of the Lehigh Valley. This car carries a series of carborundum bricks that are brought into contact with the rails as the car moves along. When in operation the car moves at a speed of about 20 miles an hour, and anywhere between 5 and 15 trips must be made over the rail before the peaks of the corrugations are ground down satisfactorily. Even then they may not disappear entirely and the pattern may still be recognized. After they have been ground down it is significant that, instead of reappearing, the corrugations gradually blend into each other so that a smooth running surface is re-established. The cost of operating this machine is about $ 20 per mile.

Welding a live subject.

Considerations entering into the building up of battered rail ends comprise probably the livest subject to be dealt with in any discussion of rail conservation. Rail-end batter is probably the most important factor leading to the necessity for renewing rail, and in an effort to prolong the life of rails damaged by this defect many railroads have adopted as regular practice the building up of battered rail ends by either the oxy-acetylene or the electric-arc process.

In my opinion, such welding has been overdone in some instances. This sometimes happens when welders are assigned to given territories and are allowed to build up rail ends before such action becomes necessary, or to reweld rail ends in a relatively short time after the first application. Moreover, I have encountered instances in which one division of a road has accounted for a

(**) For a detailed description of this car see *Railway Engineering and Maintenance*, for September, 1934, page 472.

much as 75 per cent of all rail end work done on that road, the implication being that someone on that division was partial to rail end welding to the extent that it was allowed to be carried beyond actual needs. It is inconceivable that all bad joints should occur on one or two divisions.

The fact cannot be overlooked that welding is a casting proposition and that metal applied in this manner is not of the same degree of excellence as the parent metal. In my opinion much welding can be avoided by grinding abutting rail ends to correct the surface relationship between them. It is not my intention to advocate that welding be shunned entirely but simply that it be used with discretion.

Departures in rail manufacture.

Much progress has been made in developing means of prolonging the life of new rail. In this movement the steel mills have been an important factor. The metallurgical departments of the mills are continually assuming more responsibility for the quality of the steel produced and maintain a constant surveillance of the various processes by means of representatives, who are stationed everywhere about the plants. These representatives are vested with authority to reject any product at any point in the process which in their judgment does not measure up to the desired standard. Thus an effective check is maintained on the operating department, whose chief aim is to maintain the rate of production.

The steel mills have also been active in developing new processes and because of this work the metallurgical laboratories at some plants are veritable beehives of activity. This development is largely a result of what is rapidly becoming an almost universal demand on the part of railroads for the heat control of rails in production, and also because of the growing practice of many roads of specifying that rails be end-hardened at the mill.

Controlled cooling.

To many the term « controlled cooling » is somewhat mysterious, but in reality the principle involved is quite simple. When rails are cooled rapidly through the range between 500° and 600° F., which is known as the brittle range, the metal in the interior of the head is likely to be shattered or torn apart. Not all rails are susceptible to this effect, and it is not definitely known why some rails are or what the inducing causes might be, whether chemical, structural or physical. However, it has been discovered that, if newly-rolled rails with a temperature of 800° to 1 000° F. are covered so that the rate of cooling is slowed down, the shattering could be eliminated. While simple, this process is effective, and, since it is definitely known that shattering is a major factor in the formation of fissures, controlled cooling holds promise of doing much to alleviate the severity of the troublesome fissure problem.

Brunorizing.

The United States Steel Corporation, by means of its so-called normalizing or Brunorizing process, has attacked the problem in a somewhat different manner. The purpose of this process is twofold. First, by equalizing the temperature in the rail the stresses set up during the rolling process are eliminated, thus placing the steel in position to avoid shattering in the interior of the head of the rail. Secondly, the temperature of 1 525° F. to which the rails are heated is sufficiently high to bring about a refinement in the grain of the metal. The hardness of the rails is not materially affected in either the normalizing or controlled cooling processes.

It should be borne in mind that controlled cooling and normalizing are not considered cure-alls for every type of

rail failure. While they will have an important influence on the elimination of fissures and, possibly, horizontal split heads, they will have little effect on other types of failures, such as common vertical split heads, split webs, bolt-hole fractures and base breaks.

The end-hardening of rails is another important development in the railroad's campaign of rail conservation. End hardening may be appplied to either hot or cold rails. When the process is applied to cold rails the portions to be hardened must be brought to a temperature of about 1 500° F. to obtain the proper hardness. There is still considerable difference of opinion as to how hard rail ends should be, and to what length and depth the rail end should be hardened.

My position in regard to the advisability of hardening rail ends is somewhat neutral. However, there is some question in my mind as to the desirability of subjecting metal of rail-steel grade to a quick heat-treating process, for this is what happens when cold rails are treated. The entire process of heating the rail and quenching it requires about three and one-half to four minutes; this means that the steel must withstand a good deal of punishment.

Moreover, a thorough study of rail-end hardening is being made in connection with the rail investigation which is in progress at the University of Illinois. In the course of this study samples of end-hardened rails from five or six mills have been studied and it has been found that the extent of the hardened metal and also the etch pattern differ widely. In some cases the treated area was found to be very shallow, and in others it was found to extend down into the web. In view of these findings it will be interesting to note the condition of the rail ends after they have been in service five or ten years.

[625 14 (01, 621. 135 (01 & 625. 2]

Method of registering slight displacements. Results of some measurements,

by Mr. BANCELIN,

Ingénieur principal à la Division du Service Général du Matériel et de la Traction, French National Railways Company (Western Area).

(Revue Générale des Chemins de fer.)

It is obvious that the registration of the displacement of rolling stock parts in relation to each other as well as the displacement and deflection of the rails is of interest when studying the behaviour of running vehicles. During the last few years, several experimenters have endeavoured to solve this problem.

With this object an apparatus was designed and constructed eighteen months ago at the laboratory of the former French State Railways, which can be used for numerous purposes. A short description of this apparatus is given below, together with the results obtained when it was first used for studying the deformation of the track.

The principle of the apparatus (fig. 1) is to record the variations in capacity of an electric condenser, the armatures of which are joined to the two parts whose reciprocal displacement it is desired to measure.

In the laboraty the measurement of th

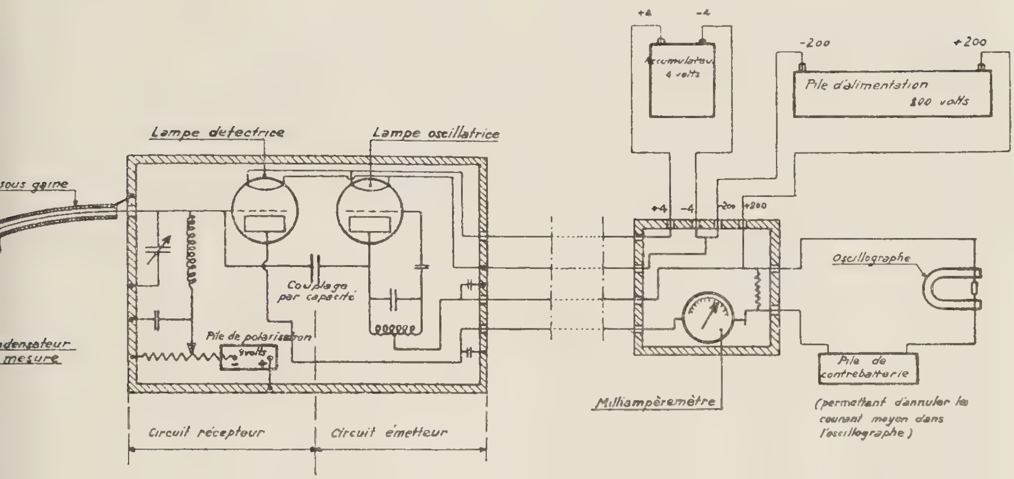


Fig. 1. — Diagram of apparatus.

Explanation of French terms :

Câble sous gaine = sheathed cable. — Condensateur de mesure = measuring condenser. — Lampe détectrice = detector valve. — Lampe oscillatrice = oscillator valve. — Couplage par capacité = capacity coupling. — Pile de polarisation, 9 volts = grid bias (9 volts). — Circuit récepteur = receiving circuit. — Circuit émetteur = transmitter circuit. — Accumulateur 4 volts = 4-volt accumulator. — Pile d'alimentation, 200 volts = H. T. battery, 200 volts. — Milliampèremètre = milliammeter. — Pile de contre-batterie, etc... = counter-battery allowing of the cancelling of the average current in the oscillograph.

variation in capacity of a condenser is easily carried out by means of an electrometer, but it is not convenient to use this academical process in the case of an apparatus intended for use on a locomotive or near the track, as much on account of shocks and variations as of the difficulty of ensuring the perfect electrical insulation necessary for the working of an electrometer. Besides, it was necessary to register very rapid variations in capacity, which requires the use of an oscillograph.

The process chosen is the following : The measuring condenser forms part of a circuit containing an inductance coil, the natural period of electrical oscillation of which is very near to that of a high-frequency transmitting circuit. The two circuits are coupled by an inductance or a capacity. The intensity of the current in the excited circuit is approximately proportional to the variations in capacity of the condenser if the device is so regulated that the functioning point is in the neighbourhood of the inflection point of the resonance curve. This high-frequency current is detected by means of a valve and registered by an oscillograph. The measurement and registration of this current intensity allows, after adjustement, the value of the variation in capacity of the condenser to be deduced and, as a consequence, the displacement of the armatures.

In each specific case an appropriate shape is given to the condenser; a cylindrical condenser is often convenient because its variations in capacity are proportional to the displacement of the plates. It can be composed of several cylinders fitting one in the other, in order to increase the sensitiveness. The oscillograph we have used is a Dubois oscillograph which is robust, and the frequen-

cy of which is approximately 1 100, which is sufficient for the experiments we have in view. We, therefore, attained a displacement of the luminous pointer twenty times the displacement of the armatures of the condenser. It is easy, of course, to reduce the sensitiveness of the apparatus, by varying the electrical constants of the circuits. Finally, by inserting an amplifying valve in front of the oscillograph we have been able to obtain movements of the pointer which are 80 times the displacement of the armatures.

The circuits carrying the high-frequency currents should be as short as possible and they must be well protected both from an electrostatic and electrodynamic point of view.

The apparatus, for practical use, is therefore mounted in the following manner :

The measuring condenser, fixed to the parts the movement of which is being studied, is joined by a sheathed cable less than 2 m. (6' 6 3/4") long, to a box, the dimensions of which are 25 × 12 × 12 cm. (10" × 4 3/4" × 4 3/4") containing the high-frequency oscillator circuit ($\lambda = 46$ m.) and the detector lamp. This box is joined to the primary battery and accumulators, and to the oscillograph by cables which can be of any length, as they carry only continuous currents.

The first use made of this apparatus was to study the track deformations produced by passing trains.

One end of the unit composed of cylindrical variable condensers, the axes of which are perpendicular to one another, can be fixed one to the rail and the other to pegs driven deeply in the ground (fig. 2). This arrangement enables the vertical and lateral deformations of the track in relation to the neighbouring ground to be studied. It only weighs about 10 kgr. (22 lb.) and takes little time to put in position. The box containing the oscillator and the detector valve is placed near the track. The primary battery and the oscillograph can be placed in a light tent 25 to 30 m. (80' to 100') further away.

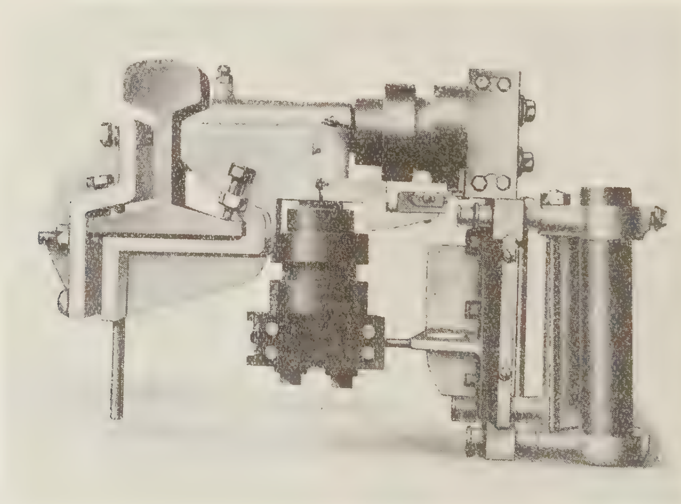


Fig. 2.

Two series of tests have been carried ıt on Vignole rails, one near Bonnières ation at the commencement of a curve ıd the other at Poissy, on a straight ction. Figure 3 gives, as an example, a ɔrtion of the diagrams taken at Bon- ères. The results obtained can be sum- arised as follows :

(1) The vertical displacements of the il vary greatly from one point to ano- er. Between perfectly packed sleepers e displacement is approximately 1 mm. 3/64"). Between two sleepers bearing ı the ballast but insufficiently packed, displacement of 4 mm. (5/32") was und during the passage of a *Pacific* comotive.

(2) Differently loaded pairs of wheels oduce rail depressions differing little value. With loads of and over 3 tons e increase in the depression is slight. This finding is of a nature to inspire tle confidence in the results of calcul- ions based on the hypothesis of an erage coefficient of elasticity of the ıck.

(3) We had hoped to show the in- ıence of the inertia of moving parts nnected to the driving wheels of loco- ɔtives; unfortunately it appears that s project must abandoned. The di- rgences relatively to the average of different measurements made at same point on the rail under passing comotive driving wheels are not grea- than those obtained with locomotive rrying wheels or carriage wheels. The namic effects which should depend on position of the rods, do not make mselves felt clearly.

(4) The registration of vertical dis- cements has shown that the rail vi- ites with a period of 0.006 second.

(5) The lateral displacements of the l varied a great deal between one nt and another, but were always ht. They varied from 0 to 1 mm. 64"). The registrations show that

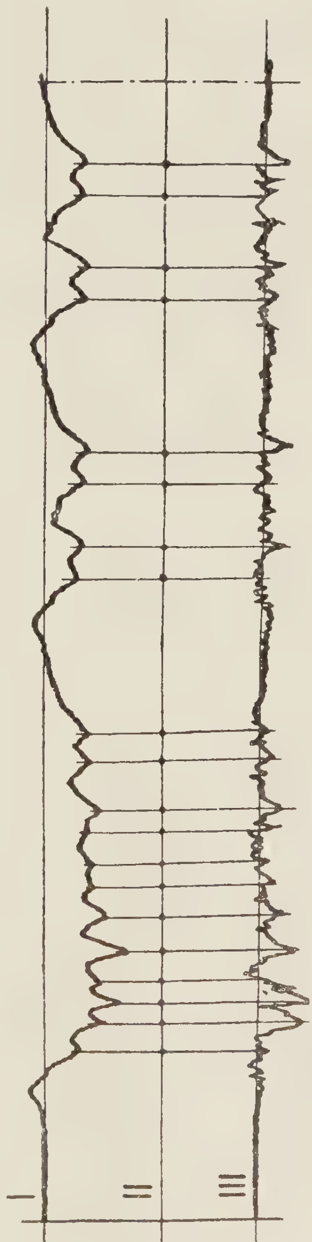


Fig. 3. — Track locations near Bonnières station, where records were taken on the passing of express No. 138 on the 27th January, 1937.

I. Vertical displacements, magnified 5 times.

II. Wheel passages.

III. Lateral displacements, magnified 15 times.

these displacements are due to blows and not to progressively variable forces as in the case of the vertical depressions.

For both the vertical and lateral displacements, the values found depend much more on the position on the track where the measurement is made than on the nature of the vehicle.

(6) We were surprised to ascertain that on a straight section the lateral displacement of two rails usually occurred simultaneously towards the centre of the track. Tests made on the line as well as in the laboratory have led us to suppose that this drawing together of the track was due to the fact that the contact with the wheel was not made in the symmetrical plane of the rail, because of the conicity of the tyre, which brings about an overturning couple which incline the two rails towards the inside.

(7) The apparatus, when placed on joint, showed that there are two blow at an interval of 0.01 second.

All these results, which were obtaine with very simple and cheap apparatu agree absolutely with those obtained c the Polish railways by Dr. Alexandr Wasiutynski and published at the tin of the last Railway Congress (Pari 1937) (*Bulletin*, Oct. 1937, p. 2 000).

We have not attempted to check the experimental results by calculations satisfactory hypotheses could not l made on the elastic properties of t track, which vary greatly from o point to another.

[621. 131]

The analysis of locomotive test data,

by LAWFORD H. FRY,

(*The Engineer.*)

An earlier article (*The Engineer*, November 20th, 1936) discussed methods of locomotive testing, and expressed the opinion that there was need for survey and assimilation of existing test results. The data at present available should be codified so as to establish general principles to be used in guiding research in the future.

The present article is an attempt to take a step in the direction indicated. A very complete series of test results from the Pennsylvania Railroad is examined. The purpose is not only to give specific information regarding the locomotive tested, but to develop definite methods for presenting the results of locomotive tests. With this in view the general principles underlying locomotive performance are examined, and an attempt is made to map out the general pattern of the processes involved.

Test data.

The tests were made with Pennsylv nia Railroad M 1 A *Mountain* 4-8-2 ty locomotive, No. 6872. Information r garding these tests has not been publis ed, but is made available for the pres purpose through the courtesy of Mr. W. Hankins, assistant vice-preside chief of motive power of the Pennsylv nia Railroad. The principal dimensio of the locomotive are given in a tab It is a two-cylinder, single-expansio 4-8-2 or *Mountain* type. The fire-b 6 ft. 8 in. wide by 10 ft. 6 in. long, giv a grate area of 70 square feet, and fired by a type B standard stoker. T flues measure 19 ft. between tube shee There are 120 2 1/4 in. and 170 3 1 in. flues. The larger flues carry sup heater pipes of the Superheater Com ny's type E.

Methods of testing.

The locomotive was tested on the ting stand at Altoona, the range of nditions extending considerably be- v and above normal running capaci- s. The Pennsylvania locomotive labo- ory is well known and will not be scribed in detail here. In each test the omotive is run at constant speed and -off for a sufficient length of time to ablish uniform conditions of oper- on and to allow of the necessary mea- rements to be made with proper ac- racy. The fact that the locomotive erates in the laboratory building ables all measurements of pressures, nperatures, etc. to be made with con- nience and with a high degree of pre- ion.

Comparison of test results.

In studying and comparing the results locomotive tests it is highly desirable choose methods which measure and mpare details of the vital processes of omotive operation. In broad outline, se processes are :

A. *Operation of boiler.* — (1) The fuel fired and part of it is burnt, pro- cing heat. (2) Part of the heat pro- ced is taken up by the heating surface. Part of the heat taken up is utilised in evaporating and superheating the steam, while the remainder is lost by external radiation.

B. *Transfer of steam to cylinders.* — The steam is transferred through the dry pipe and the superheater to the cylin- ders, with some pressure loss.

C. *Utilisation of steam.* — The steam is utilised in the cylinders, part of its thermal energy being transformed into mechanical energy and transmitted to the driving wheels.

D. *Exhaust.* — The steam from the cy- linders is exhausted to evacuate the smoke-box, so that the partial vacuum thus produced may allow the atmosphe- ric pressure to force through the fire- box the air necessary for combustion.

A completely satisfactory series of locomotive tests would provide inform- ation as to the details of all of these pro- cesses individually, and would show how they vary under varying conditions of working.

Test results.

No attempt will be made to present here all the test figures available. The purpose of the present study is to exa-

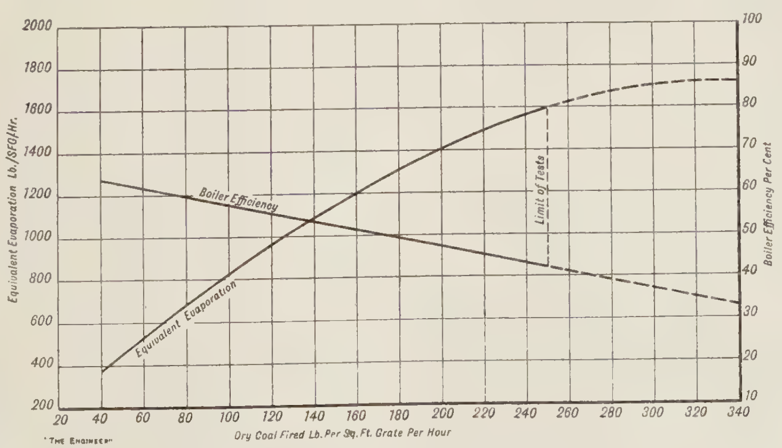


Fig. 1. — Boiler efficiency and equivalent evaporation test results.

mine the general results, and also to consider how far these serve in analysing the individual processes outlined above.

Boiler tests.

The primary purpose of a boiler test is to observe the relation between input, heat units in the coal fired, and output, heat units in the steam produced, and to see how this relation varies as the rate of operation is varied. Information on these two points is given in figure 1. In this figure the scales for the ordinates and for the abscissæ are not marked directly in B. T. U., but in pounds of coal fired and in pounds of equivalent evaporation. It would be more logical and slightly simpler, where two locomotives working with different fuels are compared, to mark the scales directly in heat units. The drawback is that one is accustomed to think of boiler input and output in terms of pounds of coal fired and pounds of water evaporated, and heat units do not give so direct an impression of the running rate of the locomotive. To speak of a firing rate of 1 418 500 B. T. U. conveys a less definite idea of working conditions than to speak of a firing rate of 100 lb. of coal per square foot of grate per hour. In figure 1 the firing rates are plotted on the basis of pounds of dry coal having a heating value of 14 185 B. T. U. per lb., which corresponds to the coal used in the Pennsylvania tests.

Evaporation is measured in pounds of equivalent evaporation, that is, by the number of pounds of steam that would be produced from and at 212° F. by the same heat as is required for the production and superheating of the actual steam. Each pound of equivalent evaporation represents 970 B. T. U., while from 20 to 30 per cent. more heat is required for each pound of steam actually produced. Consequently, the equivalent evaporation shown in the plots is some 20 to 30 per cent. more than the pounds o steam actually produced.

In figure 1 firing rates and rates of evaporation are shown in terms of pound per square foot of grate per hour, abbreviated to lb./SFG/hr. The curved lin shows the relation between rate of evaporation and rate of firing. The straigh line shows the relation between overal boiler efficiency and rate of firing. Th rate of firing was carried up to abou 250 lb./SFG/hr. It must be understoo that this rate, while in can be maintaine for half an hour or more, is about twic that which the boiler is designed t maintain under normal road condition Taking 125 lb. of coal per square foot o grate per hour as a good representativ rate of firing for loaded running condi tions, the corresponding equivalent rat of evaporation would be about 1 000 lb of steam from and at 212° F. per SFG/hr with an overall boiler efficiency of abou 55 per cent.

Boiler efficiency.

The overall boiler efficiency plotted i figure 1 is dependent on two factors (*a*) the efficiency with which the coa is burnt to produce heat; and *(b)* th efficiency with which the heat produce

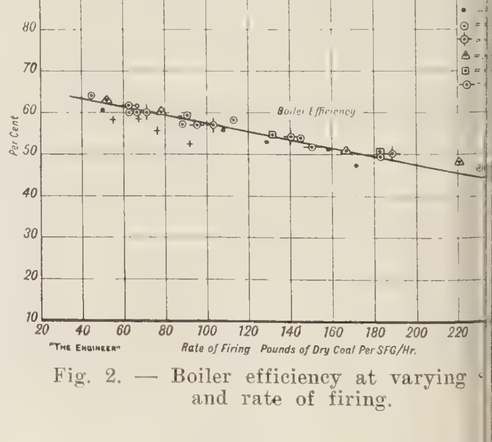
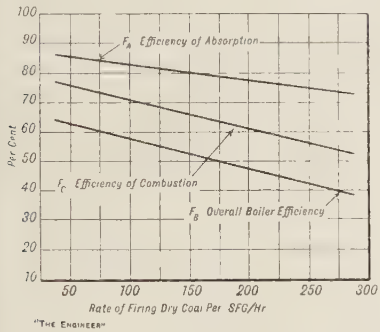


Fig. 2. — Boiler efficiency at varying and rate of firing.

s taken up and utilised by the heating ınd superheating surfaces.

In the Pennsylvania tests analyses of he smoke-box gases were made and the smoke-box temperatures accurately meaured. This information enables the overall boiler efficiency to be separated nto its component efficiencies of combustion and heat absorption. The values obtained are shown in figure 3. It is



'ig. 3. — Boiler efficiencies and firing rate.

vident that as the rate of firing is increased the efficiency of combustion lrops much more rapidly than does the fficiency of heat absorption. As the ring rate is increased from 50 lb. to 50 lb./SFG/hr. the efficiency of combustion drops from about 76 to about 6 per cent. The corresponding change n the efficiency of heat absorption is rom 85 to 75 per cent. This general elation between the rate of firing and ie component boiler efficiencies is haracteristic of all locomotive boilers. he efficiency of heat absorption is ever affected as greatly by the rate of ring as is the efficiency of combustion nd, moreover, it varies only slightly rom one boiler design to another.

Method of plotting boiler test results.

Before leaving the subject of boiler efciency attention is called to the form of otting used in figures 1 and 3. The rate firing is used as the independent variable, and boiler efficiencies and ratios of evaporation are plotted against it. The choice of firing rate as the independent variable is not a haphazard selection, but is based on a wide study of locomotive boiler tests. Experience shows that the overall boiler efficiency plotted against the firing rate invariably gives a very satisfactory straight line relation between the two. When this straight line has been established for the boiler efficiency it follows as a matter of simple algebra that the evaporation must be represented by a parabola. This curve characterises very well the relation between the rates of firing and evaporation. As the rate of firing is increased the rate of evaporation increases, but at a decreasing rate, and tends to approach a maximum. From the equation to the straight line the maximum rate of evaporation can be computed as well as the corresponding rate of firing. In actual testing it may not be possible to push the boiler to this maximum; nevertheless the test results will be found to conform to the pattern of the straight line and parabola. For a more detailed study of the question see « A Study of the Locomotive Boiler », by the present author, Simmons- Boardman Company, 1924.

The close adherence to the straight line relation when boiler efficiency is plotted against rate of firing is clearly shown in figure 2. In plotting the test results each point is marked to show the speed in r.p.m. at which the engine was run during the test. Three of the tests at the lowest speed of 40 r.p.m. tend to fall below the straight line, but otherwise the agreement is excellent and there is no indication that the engine speed *per se* has any systematic influence on the boiler efficiency.

It is the writer's opinion, formed after the study of a large number of locomotive tests, that the speed and cut-off at which the engine runs have no practical effect on the boiler efficiency except as they determine the amount of

steam which must be supplied to maintain stable conditions of operation.

Air supply for combustion.

If a complete study of the operation of a locomotive boiler is to be made, it is essential to have information as to the amount of air supplied to the fire-box for combustion. Information on this important point is given in all of the later tests made on the Altoona locomotive testing plant, and figure 4 shows the rate

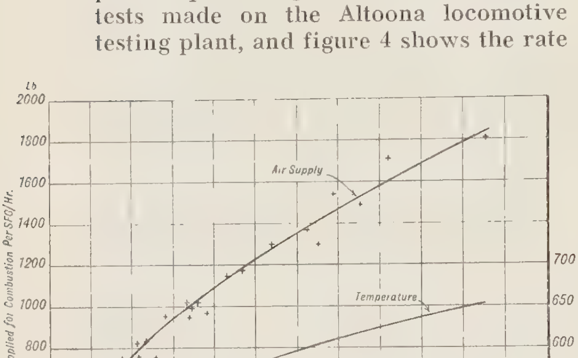


Fig. 4. — Air supply conditions.

at which the air was supplied in the tests on the Pennsylvania locomotive now under consideration. This information, together with the smoke-box temperature, also shown in figure 4, is necessary if the overall boiler efficiency is to be broken down into its components of combustion and heat absorption.

It seems unfortunate that greater attention has not been given to the question of the air supply of the locomotive. As said above, the later tests at Altoona provide information as to the rate at which air is supplied for combustion. Unfortunately, other experimenters have often contented themselves with pointing out the difficulties involved in making gas analyses and smoke-box temperature measurements. They also point out that such measurements cannot be used to compute a heat balance unless the losses due to the escape of unburnt fuel can be evaluated. This is true, and it is also true that it is difficult, if not impossible, to measure directly the amount of fuel which escapes unburnt. Goss used a small sampler tube traversing the top of the stack to estimate the quantity of the sparks escaping. At Illinois and Altoona attempts have been made to collect and measure all unburnt fuel. No satisfactory results have been obtained. The resulting heat balances attribute from 5 to 15 per cent. to external and unknown losses. As the external losses are only of the order of 2 per cent. there is an undesirably large element of uncertainty. This is particularly true at the high rates of evaporation. A heat balance which shows 15 per cent. loss in smoke-box gases, 15 per cent. loss by unburnt fuel, and 10 per cent, loss by unknown causes is of very little value in a critical examination of boiler design and operation.

Because of the difficulty of measuring accurately the fuel which escapes unburnt, the present writer developed another method of attack (*loc. cit.*). From the smoke-box temperature and the gas analysis it is a simple matter to compute the heat lost in the sensible heat of the gases for each pound of fuel actually burnt. This figure deducted from the heating value of the fuel gives the heat absorbed by the boiler per pound of fuel actually burnt. The total heat absorbed by the boiler per hour is accounted for by the heat in the steam, which can be measured, and the external losses which can be estimated within a small margin of error. Therefore the total heat absorbed by the boiler per hour is known. Dividing this by the heat absorbed per pound of fuel actually burnt gives the weight of fuel actually burnt

er hour. Deducting this figure from the eight of fuel fired per hour we get the mount of fuel which escapes unburnt.

Smoke-box draught.

It is a commonplace, but worth re-embering, that the performance of our odern locomotives depends on the ef-ect observed by George Stephenson hen he turned the exhaust pipe of the Rocket » up the stack. Writing in 858 (*) regarding the development of e blast pipe, Robert Stephenson said : A series of experiments was made with last pipes of different diameters, and eir efficiency was tested by the mount of vacuum that was formed in e smoke-box. The degree of rarefac-on was determined by a glass tube xed to the bottom of the smoke-box nd descending into a bucket of water ». his principle is, of course, used to-day testing locomotives, but for a com-lete study of the blast action more ex-nsive measurements are desirable.

In such a study four quantities require onsideration :

(1) The rate at which steam is ex-usted through the blast nozzle.

(2) The rate at which the gases of ombustion are moved through the oke-box as a result of the ejector tion of the exhaust.

(3) The back pressure in the exhaust ssages of the cylinders.

(4) The draught or partial vacuum set in the smoke-box as a result of the ector action.

In presenting test data the method of otting used in figure 5 is recommend-. This is adapted from the very com-ete study of the subject made by Pro-ssor Everett G. Young, « A Study of Locomotive Front-End », *Bulletin* . 256 of the Engineering Experiment tion of the University of Illinois. The curves shown in figure 5 have been developed by the present writer from the test data under consideration.

The curves in quadrant I of figure 5 show the relation between the rate at which steam is exhausted and the rate at which the gases of combustion are evacuated. This is the basic relation on which the action of the locomotive front end depends. The detail of the plot from which the curves are derived is given in figure 6. All the tests can be represented by three straight lines, one for an engine speed of 40 r.p.m., one for 80 r.p.m., and the third for speeds of 120 r.p.m. and over. For each line—that is, for each engine speed, the weight of gases evacuated is directly proportional to the weight of steam exhausted, the proportionality having the following values :

Engine speed, 40 r.p.m... gases/steam = 2.24.
Engine speed, 80 r.p.m... gases/steam = 2.00.
Engine speed, 120 r.p.m. and over... gases/steam = 1.86.

The greater weight of gas evacuated per pound of steam at the lower speeds is due to the higher enthalpy of the

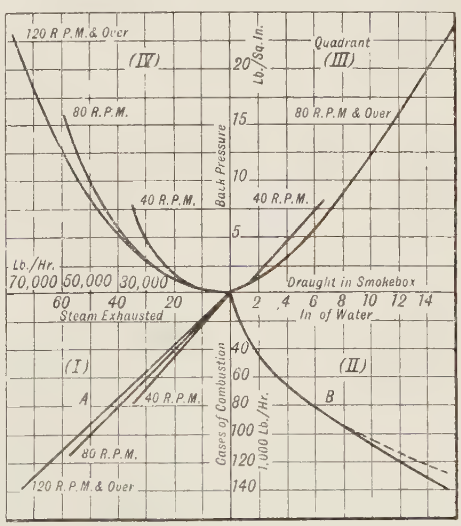
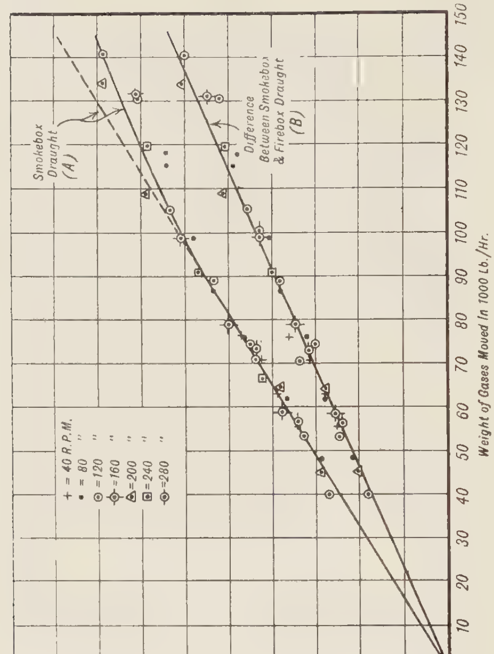


Fig. 5. — Test data plotted.

(*) Apparently to *The Engineer*. See « A ...tury of Locomotive Building », pp. 227. J. H. G. Warren.



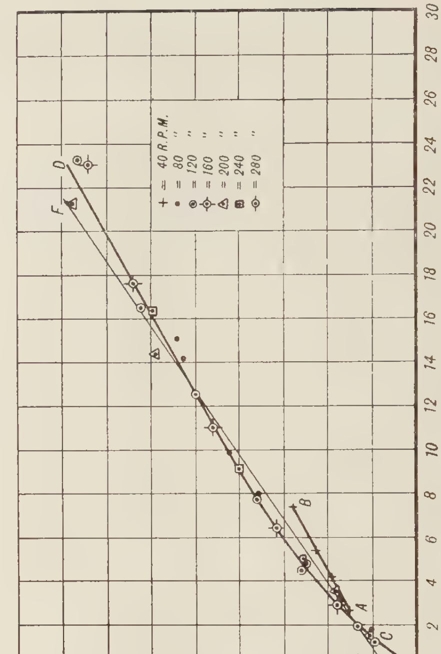


Fig. 8. — Square root of draught and weight of gases.

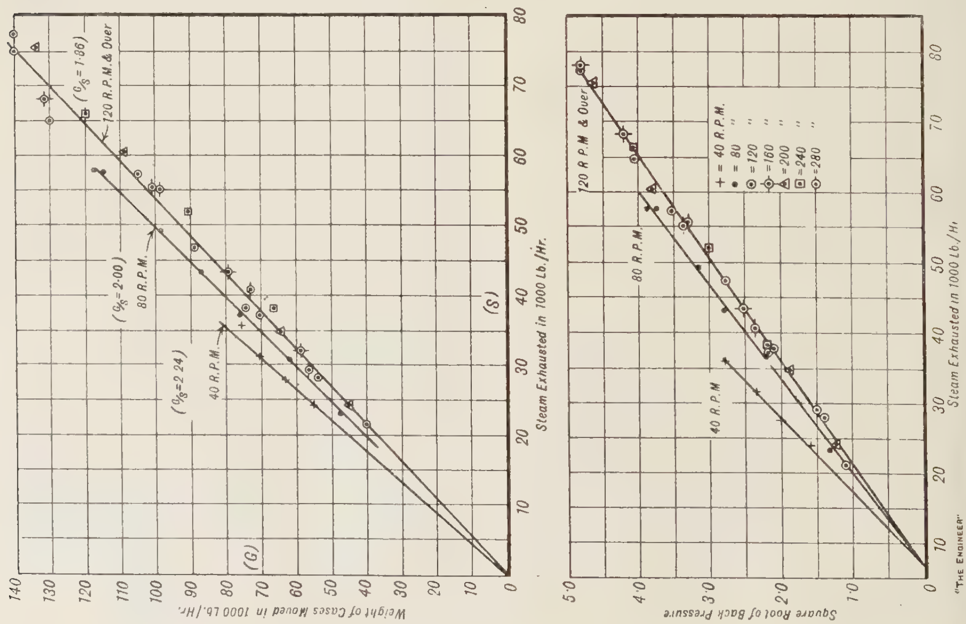


Fig. 6. — Weight of gases and steam exhausted.

exhaust steam. It is evident that if a given weight of steam is to pass through the cylinders at various engine speeds, the cut-off must be longer for the lower speeds. This means less expansion, less heat converted to work, and, consequently, greater enthalpy of the exhaust steam at the low engine speeds. Details of this are given in figure 14 on page 1228. It can be seen, for example, that with 35 000 lb. of steam exhausted per hour the enthalpy of the exhaust steam in the Pennsylvania locomotive is :

At 120 r.p.m.	1168 B.T.U./lb.
80 r.p.m.	1180 B.T.U./lb.
40 r.p.m.	1216 B.T.U./lb.

At lower speeds the greater heat energy in the exhaust steam results in greater velocity of the steam after expansion in the exhaust nozzle and in a higher back pressure. The latter effect is shown in quadrant IV of figure 5, and in figure 7.

In figure 7 the relation between back pressure and rate of steam exhausted is shown in detail by plotting the square root of back pressure against rate of exhaust. Within the range of the test data, all of the results are well represented by three straight lines. The lines do not pass through the origin. If they did, the back pressure for a given engine speed would be directly proportional to the square of the rate at which the steam was exhausted. This condition would obtain if the steam exhausted at a given engine speed were of uniform quality for all rates of flow. Reference to figure 14 shows that this is not the case. At a given engine speed the enthalpy of the exhaust steam increases as the rate at which steam is exhausted increases. For this reason the increase in back pressure with increasing rates of exhaust is greater than it would be if it were directly proportional to the square of the weight of steam exhausted per hour.

In addition to the weight of steam exhausted, the velocity of the exhaust must be considered. An increase in velocity may be obtained by decreasing the orifice of the nozzle, or, as described above, by increasing the enthalpy of the exhaust steam.

The curves in quadrants I and IV of figure 5 and the conclusions drawn from them give the basic information necessary for a critical examination of the action of the front end.

The air used for combustion, together with the waste products (gases of combustion), is entrained by the exhaust steam and ejected through the stack. The effectiveness of the ejector action of the steam — that is, the weight of gases entrained per pound of steam — depends on the velocity with which the exhaust steam expands through the nozzle. This velocity can be increased by reducing the area of the nozzle or by increasing the heat energy in the exhaust steam.

This reasoning is predicated on the design of front end remaining unchanged. It is, of course, possible to vary the design and alter the weight of gas entrained per pond of steam for a given back pressure. If various designs of front ends and blast nozzles are to be compared for efficiency, a plot of test results as in quadrants I and IV of figure 5 is useful and sufficient. It shows how much gas is moved by each pound of steam exhausted and whether this is done without undue back pressure. Back pressure is, of course, undesirable as it reduces the available cylinder power.

Consideration of the smoke-box draught is unnecessary if proper information is available as to the weight of gas moved. The draught is merely a secondary phenomenon dependent on the rate of flow of, and the resistance offered to, the gases of combustion. It has, however, by right of ancient usage acquired a certain quasi-respectability and cannot be overlooked entirely. Information as to the relation between draught and back pressure and between draught and rate

of gas flow is given in quadrants III and II of figure 5.

Details of the relation between smoke-box draught and rate of gas flow in the Pennsylvania locomotive are given in figure 8, from which the smooth curves in quadrant II of figure 5 are taken. Two sets of test results are plotted with the rates of gas flow as abscissæ and the square root of draughts as ordinates. The lower set of points gives the difference between the draught in the smoke-box and the draught in the fire-box. This measures the loss of head incident to the flow of gas through the flues. The points are well represented by the straight line B, showing direct proportionality between loss of head and the square of the rate of gas flow. The upper points, smoke-box draught, are well represented by the straight line A to a rate of flow of about 100 000 lb. of gas per hour. This corresponds to a rate of firing of about 150 lb. of coal per square foot of grate per hour. At higher rates of firing and gas flow the measured smoke-box draught falls below that predicted by the line A. To obtain the high firing rates front end by comparing smoke-box draught and back pressure. The practice has, of course, grown up because of difficulty in measuring the rate of gas flow.

The relation of back pressure to smoke-box draught for the Pennsylvania locomotive is shown in figure 9 on page 1222 with back pressures as abscissæ and draughts as ordinates. Without further study of the data it would be natural to represent the points by a straight line EF. This does not pass through the origin, but indicates a draught of about 1 in. of water for zero back pressure. Ellis and Fetters in their 1936 report on the Locomotive Front End to the Committee on Locomotive Construction, Association of American Railroads, Mechanical Division, show an almost identical line as a typical draught curve. They suggest that the positive draught for zero back pressure is due to inaccuracies in the draught gauge readings. The present study does not confirm this view, but shows that a better explanation is to be found in the changes in enthalpy of the exhaust steam which have been noted above.

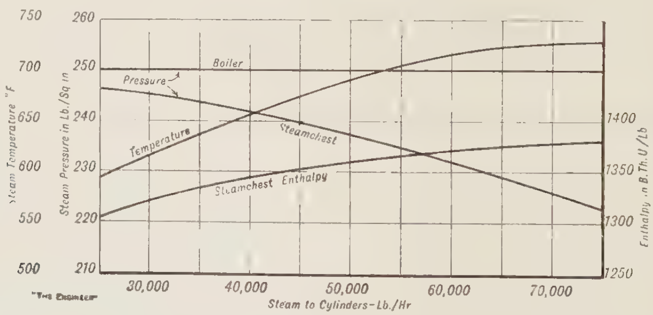


Fig. 10. — Variation of steam conditions with steam supply.

the fire must be thinner or more permeable. Its resistance to the passage of the air is lower and continuity of the relation between smoke-box draught and rate of gas flow is broken. This is a serious objection to the widely prevalent practice of measuring the effectiveness of the

The data available also show that the relation between smoke-box draught and back pressure cannot be accurately represented by a single straight line applicable to all engine speeds. The smooth curves in figures 6, 7 and 8, which are the same as those in quadrants I, II, and

V of figure 5, show respectively the relations, back pressure v. steam flow, steam flow v. gas flow and gas flow v. smoke-box draught. By correlating the values given by these curves, the relation between back pressure and smoke-box draught can be obtained. Curves giving this relation are shown in quadrant III of figure 5, and in more detail in figure 9. The points fall into two groups. Those at the lowest speed of 40 r.p.m. are well represented by the straight line A B. For the higher draughts obtained at speeds of 80 r.p.m. and over the curve C D applies.

It should be noted that the separation of the plot into these two groups would not be clearly justified without the information given in quadrant I of figure 5 as to the relation between steam exhausted and weight of gases moved. If no information were available as to the rate at which air was supplied, the analysis of the draught conditions would be incomplete. It would then be natural to follow Ellis and Fetters and represent the relation between smoke-box draught and back pressure by the straight line E F in figure 9. The difference between the straight line and the actual results would not be serious if only a single series of tests for one locomotive is to be recorded. If, however, test data are to be studied with a view to improving existing conditions, it is of advantage to use the accurate method of plotting made available by measurement of the air supply. One gain is that it is not then necessary to account for the position of the low test points by assuming that the draught gauge measurements are inaccurate.

Determination of the air supply should be recognised as a highly important phase of locomotive testing. Our knowledge of the details of the operation of the locomotive boiler is largely due to the fact that the Pennsylvania Railroad laboratory has provided information as to the rate at which air is supplied.

Engines.

Attention is now shifted from the boilers to the engines. Here the steam which represented output from the boiler changes its rôle and takes the part of input for the cylinders. In considering the boiler output, the controlling quantity was the rate at which heat units were taken away in the steam. In examining the cylinder input it is necessary to consider the conditions of pressure and temperature under which the heat units are offered to the cylinders. High steam pressures and temperatures increase the efficiency with which the steam can be expanded in the cylinders.

In a locomotive boiler working at a constant boiler pressure, the rate at which steam is produced will affect the pressure and temperature at which the steam is delivered to the steam chests. As the boiler is forced and the output of steam is increased, the temperature at which the steam is delivered goes up. This is due to the fact that the temperature of the fire-box and of the gases of combustion rises. It is sometimes suggested that part of the increase in steam temperature is due to better heat transference in the superheater because of the more rapid steam flow. This cannot be the case. With a constant temperature of the superheater surfaces an increase in the rate of steam flow would result in more heat being taken up, but the steam would come away at a lower temperature. An increase in the rate of steam flow will increase the rate of heat transfer, but will reduce its efficiency. The increase in steam temperature as the boiler is forced has a favourable effect on the efficiency of the cylinders.

While an increase in the rate at which the boiler is worked increases the temperature, it has an opposite effect on the pressure. As the boiler is forced, the pressure of the steam reaching the steam chests is reduced. This reduction of pressure tends to reduce the cylinder

efficiency. It thus opposes the beneficial tendency of the higher steam temperature. This opposition in part accounts for the fact that locomotive cylinder efficiency usually remains constant over a considerable range of power.

Information regarding the temperature and pressure changes is given in figures 10 and 11. The range between low and high powers is indicated below :

Rate of steam flow to cylinders, lb./hr.	33 000	70 000
Pressure :		
In steam chest, lb./sq. in.	245	225
Drop from boiler to steam chest, lb./sq. in.	5	25
Temperature in steam chest, deg. Fahr.	640	725
Enthalpy in steam chest, B. T. U./lb.	1 310	1 380

Figure 11 shows in detail the relation between steam chest pressure drop and

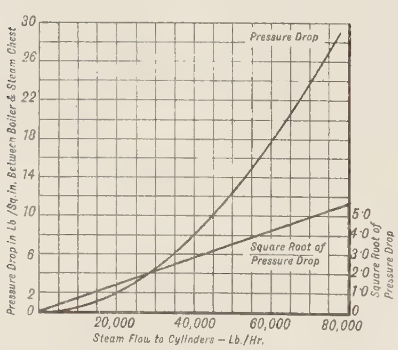


Fig. 11. — Steam chest pressure drop and rate of steam flow.

rate of flow of steam to the cylinders. For the individual points plotted the ordinates are rates of steam flow and the abscissæ the square roots of the pressure drop between boiler and cylinders. A very good straight line relation is obtained showing that the pressure loss is a friction loss proportional to the square of the rate of flow of the steam.

This information suggests that the pressure loss can be minimised by providing steam passages of ample area and unobstructed in direction. Effort can be well spent in reducing pressure loss between boiler and cylinders. This loss not only reduces the cylinder efficiency, but also cuts down the cylinder power that can be developed for a given cut-off.

Attention is now turned directly to the cylinders. Analysis of the action of the cylinders involves considerations of the power developed and the efficiency shown. Cylinder power is the product of two factors, speed and cylinder tractive effort, and these two factors are inter-related. They also, individually and together, influence the efficiency.

The relation between tractive effort and speed is shown in figure 12. Abscissæ are speeds in miles per hour and ordinates cylinder tractive effort. Cylinder tractive effort is defined for present purposes as the tractive effort computed from cylinder and driving wheel dimensions, using the indicated mean effective pressure. It may also be called the indicated tractive effort.

In figure 12 a series of curves is drawn sloping downward from left to right, each corresponding to a given cut-off. The equilateral hyperbolas shown in light lines give the horse-power developed for various combinations of tractive

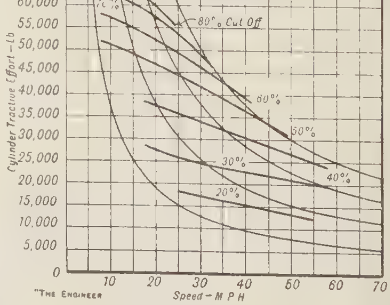


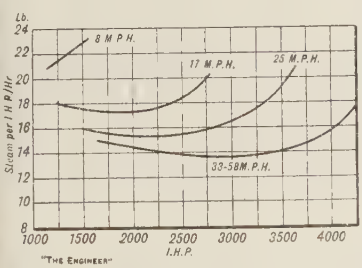
Fig. 12. — Relation between tractive effort and speed.

ort and speed. Horse-power is, of urse, proportional to the product of ctive effort and speed.

The value of the tractive effort deve-ed is dependent in the first place on cut-off, but is also affected by the ed. For example, the Pennsylvania inders at 50 per cent. cut-off give an licated or cylinder tractive effort of 000 lb. at 10 miles per hour. As the ed is increased to 50 miles an hour, tractive effort drops to 31 000 lb. At s cut-off and speed the tractive effort ve cuts the 4 000-H.P. hyperbola. No ther increase in speed can be made th this cut-off, as the capacity of the ler to supply steam has been reached. is important to note, however, that oughout the curve to the left of this int the drop in tractive effort as speed reases is due only to cylinder con-ions, and not to any limitation im-sed by the boiler.

Cylinder efficiency.

This is commonly, if not entirely accu-ely, described in terms of pounds of um per horse-power hour, as in figure Abscissæ are indicated horse-power



13. — Steam consumption and power.

ordinates steam per indicated horse-er hour. Curves showing the rela-between steam consumption and er are drawn for various speeds. It be seen that the best results are ob-ed at the higher speeds and medium er output, and that for a consider-able range of power the change in steam per horse-power hour is not great. The lowest steam consumption shown is about 14 lb. of steam per indicated horse-power hour.

While the steam rate per horse-power hour serves as a good practical index to the efficiency of an engine, it is not an exact measure of thermal efficiency. For an accurate measure of this property in-formation is needed as to the heat in the steam entering and the heat in the steam leaving the cylinders. Working from the very extensive data given by the Penn-sylvania tests, the author has devised the scheme shown in figure 14 to illustrate how and why the thermal efficiency varies.

In this figure the ordinates are ent-halpy or heat content in B.T.U. per pound of steam, while the abscissæ are rates at which steam is passed through the cylinders. The upper curve A shows how the enthalpy of the steam in the steam chests increases as the rate of steam supplied increases. In the lower part of the figure is a group of curves, marked respectively for speeds of 40 r.p.m., 80 r.p.m., 120 r.p.m., and 160 r.p.m. and over. The intersection of one of these speed curves with a vertical for a steam rate gives the enthalpy of the exhaust steam at that engine speed and that steam consumption. The 35 000 lb. an hour steam rate vertical cuts the 80 r.p.m. curve at an enthalpy of 1 180 B.T.U. This amount of heat disappears up the stack with each pound of steam exhausted. Now, if the 35 000 lb. per hour vertical be continued upwards it will meet the A curve for steam chest enthalpy at a value 1 334 B.T.U. per pound for the steam at admission. The heat utilised in the cylinders for con-version to mechanical work is found by subtraction, 1 334—1 180, to be 154 B.T.U. per pound of steam. The thermal efficiency of the engine is readily found to be 154/1 334 or 11.5 per cent.

It will be noted that across the heavier

speed lines another family of lighter lines is drawn and marked for various cut-offs. These serve to show the enthalpy in the exhaust for any combination of cut-off and rate of steam consumption.

The combination of the two families of curves shows how the various combinations of cut-off and speed affect steam consumption and efficiency. The lowest heat loss in the exhaust steam occurs, as is natural, with the shortest cut-off and the highest speed. Under such conditions there is a moderate rate of steam flow through the cylinders. As the cut-off is lengthened the rate of steam flow is increased and the heat carried away by each pound of exhaust steam also increases. This would tend to give a lower cylinder efficiency, but, as has been noted, the increase in the rate of steam flow is accompanied by an increase in the admission steam temperature. At the higher speeds the enthalpy in the steam chest, Curve A, rises very nearly parallel to the enthalpy of the exhaust. Consequently, the amount of heat taken out of each pound of steam and converted to mechanical work changes slowly. The thermal efficiency will drop slightly because a constant amount of work will be developed from an increasing enthalpy at admission, but the amount of steam used per unit of work will remain nearly constant over a fairly wide range of power. This was shown in figure 13.

It should be noted that with a value given for the heat per pound of steam converted to work the pounds of steam used per horse-power hour can be found at once. A horse-power hour is equivalent to 1 980 000 ft.-lb. or 2 545 B.T.U. Consequently, if 154 B.T.U. of work are developed from each pound of steam, the steam consumption will be 2 545/154, or 16.6 lb. of steam per indicated horse-power hour.

The method of plotting used in figure 14 is novel, so far as the author is aware. It is derived from a suggestion made by him (*Proceedings Inst. Mech. Engrs.*, 1927, Vol. 2, pp. 923-1024) that in loco motive testing it should be possible t determine steam per indicated horse power without taking indicator cards but by measuring the temperature an pressure of the steam at admission an

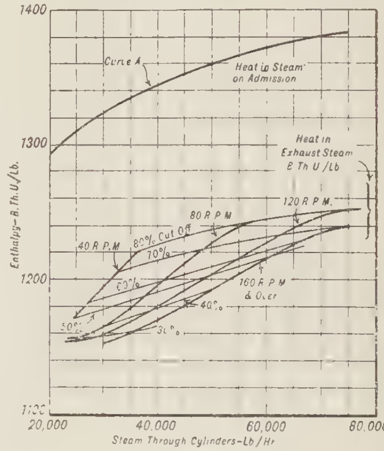


Fig. 14. — Enthalpy and steam rate.

exhaust. Since then this method of me suring steam rate has been applied pra tically by Mr. A. Williams (*Transaction A. S. M. E.*, 1935, Vol. 57, p. 495), a satisfactory results are reported. working up the test reports the valu for steam per indicated horse-power ho have been computed from the indicat cards and the total steam used, as we as from the steam temperatures a pressures. The check between the tw methods is reasonably close.

Conclusion.

Attention is drawn particularly to t pattern which has been set up for t analysis of locomotive processes. Th was outlined in the early part of t article. It is here re-stated, calling tention to the plots which have be used.

A. *Operation of the boiler.* — (1) T overall boiler efficiency is plotted as straight line against the rate of firing figure 1 (*ante*). From this straight li

e rate of equivalent evaporation is omputed and plotted as a parabola, also figure 1, against the rate of firing.) The overall boiler efficiency is bron down into efficiency of combustion id efficiency of heat absorption, figure (*ante*).

B. *Transfer of steam to cylinders.* — ıe temperature and pressure of the eam arriving at the cylinders are plotd against the rate of steam flow as in gure 10.

C. *Utilisation of steam.* — (1) The heat the steam entering and leaving the linders is examined. The difference is e heat transformed into mechanical ork. Figure 14 plots the information as to show the effect of speed and t-off on the amount of work developed ıd the efficiency with which this is ne. (2) The tractive effort developed the cylinders is shown in figure 12 in lation to speed and cut-off.

D. *Exhaust.* — The front end conditins are analysed and plotted in figure 5. ıe four related quantities to be studied e rate of exhaust of steam, back presre, draught, and rate at which gases of mbustion are moved.

It is believed that the pattern followed ovides a concise, complete, and logical account of the vital processes of the locomotive. Attention is directed only to the inter-related thermal processes of the boiler and engine. Consideration of how the power developed by these processes may be used to haul trains is another matter.

Principal dimensions of the locomotive.

Railway	P.R.R.
Locomotive No.	6 872
Type	4-8-2
Weight on drivers, lb.	267 000
Weight of locomotive, total, lb.	385 000
Cylinder diameter, H.P., in.	27.0
Cylinder stroke, in.	30.0
Cylinder volume, L. P., cu. in.	17 300
Driving wheel diameter, in.	72
Boiler pressure, lb./sq. in.	250
Flues :	
Plain, outside diameter, in.	2.25
Plain, number	120
Superheater, outside diameter, in.	3.5
Superheater, number.	170
Length between tube plates, ft.	19
Evaporative heating surface, sq. ft.	4 319
Superheating surface, sq. ft.	2 052
Superheating as per cent. of evaporative surface	47.5
Fire area of flues, sq. ft.	9.00
Grate area, sq. ft.	70.0
Fire-box volume, cu. ft.	475
Evaporative surface/grate area.	61.7

[621. 335 (.498) & 621. 43 (.598)]

Main-line oil-electric locomotive for Roumania.

(*The Engineer.*)

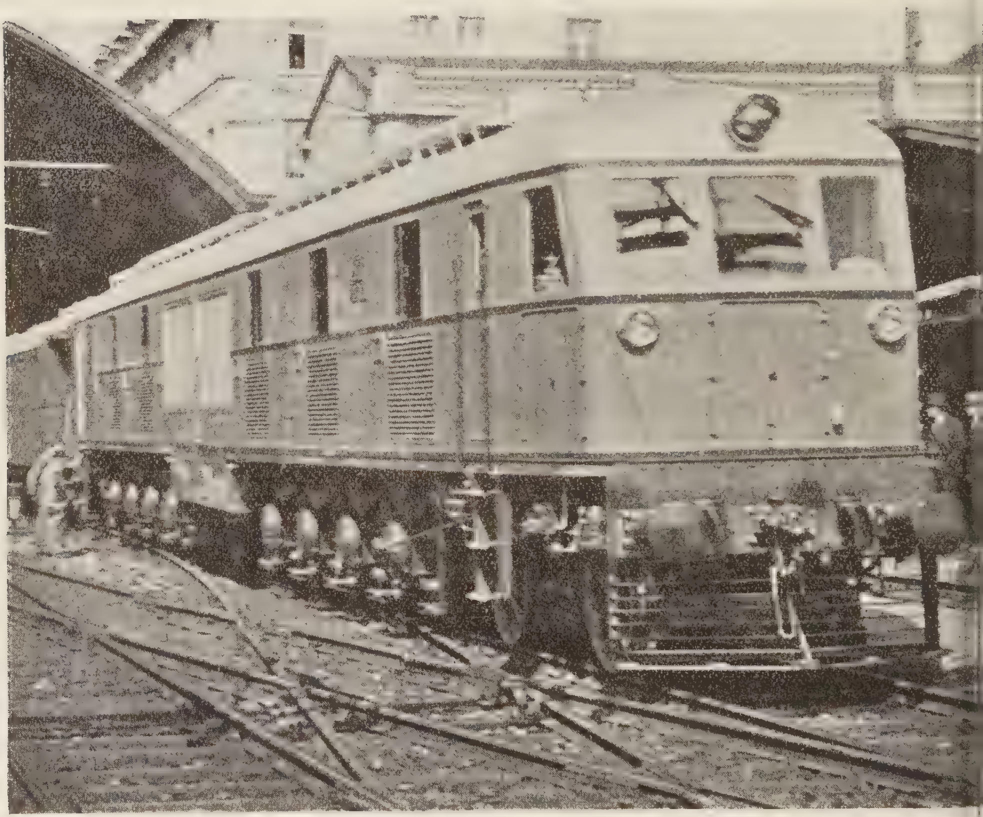


Photo : Ad. M. Hu[g]

Fig. 1. — 4 400-H.P. oil-electric locomotive.

The Campina-Brassov section of the Bucharest-Teius main line of the Roumanian State Railways (leading to Budapest), crossing a spur of the Transylvanian Alps, has long taxed those responsible for its operation, for it bears some of the most intense traffic to be found on the railway system of Roumania. There are gradients as steep as 1 in 48 on the Southern slope, subsequent t[o] a gradual rise all the way from Bucha[rest], and a maximum inclination of 1 i[n] 40 on the northern bank. The line [is] single track, and for some years thre[e] and four steam locomotives have bee[n] used on the heaviest passenger an[d] freight trains.

After various projects for doubling th[e]

ne or modernising other routes had en examined, it was decided to elecfy the Campina-Brassov section, and year or two ago the State Railway adinistration called for tenders. But the gh prices caused conversion to be stponed, and as an alternative, which that time required a good deal of couge, a high-power oil-electric locomove was ordered, with the idea that if it oved a success several such units ould be acquired, and would work esent and future traffics in a satisfacry manner.

General requirements.

As a result of the great power it is ssible to obtain from an oil-engined comotive of reasonable size and axle ading, it was felt that, not only would ich a locomotive obviate double headg at both ends of the train, and thus duce considerably the inordinate exnditure on locomotive maintenance, ew wages, and fuel, but would enable reduction to be made in the cost of ack maintenance and would eliminate e smoke nuisance.

The 4 400-B.H.P. oil-electric locomotive st delivered by Sulzer Bros., of Winrthur, as main contractors, was degned to handle unassisted 600-tonne ssenger and freight trains over the 44le mountain section on existing, and ssibly on accelerated, schedules. This vision of line includes a 6-mile graent of 1 in 40, of which nearly 4 miles e round uncompensated curves of 900 radius. The maximum axle load presibed was 20 tonnes, this being 2 tons more than that allowed for the big 3-4 steam locomotives built last year. tually, the axle load as built does not ceed 19 tonnes, and of this less than onnes is unsprung.

The output required for hauling a 600ne train uphill at a reasonable speed, , 2 150 D.B.H.P. at 20 m.p.h., or 2 700 .H.P. at 25 m.p.h., and the high tracle effort needed to start such a train on the most difficult portion, necessitated eight driving axles, and this involved the division of the locomotive into two parts. The question then arose as to whether these two halves should be built in such a way that they could be used as separate locomotives if desired. If the locomotive was always to be used as a complete unit, only one driving position, one starting battery, and a simplified control would have been necessary, and savings in length, weight, and price could be effected. Nevertheless, the locomotive has been constructed as two identical halves, more or less permanently coupled together, for as the acquisition of further locomotives was envisaged, it was thought desirable to be able to couple any two halves from different locomotives. Modifications to the buffers and draw gear would be necessary before any single half could operate a train.

Mechanical portion.

Having regard to the conditions of power and track as outlined above, the $2\text{-}D_0\text{-}1+1\text{-}D_0\text{-}2$ wheel arrangement was adopted — see pp. 1234/35 and figure 1. The chassis of each half is built up on a welded framework of 1 in. steel plates with cross stretchers of various thicknesses —see figure 2. The driving axles are without side play, and in order to provide the flexibility necessary to negotiate line curves of 900 ft. radius and 1 in 8 switches, the flanges of the second and third pairs of 53 in. driving wheels have been thinned by 9/16 in. The outer four-wheeled guiding bogie has a spring-controlled displacement at the pivot of 3 3/4 in. a side, and the inner Henschel truck has a maximum movement of 2 3/4 in. to each side. In principle, the Henschel truck is almost the same as a Bissel truck, but it has no radial arm and no actual pivot; its lateral movement is around a theoretical pivot, an action which is derived from the use of a single central swing link pin

set longitudinally at a slope. The four-wheeled bogie has a spherical pivot and flat side bearers, and between its inner headstock and the locomotive main frame structure is a spring-controlled connection to damp out hunting movements. The outer pair of wheels on each

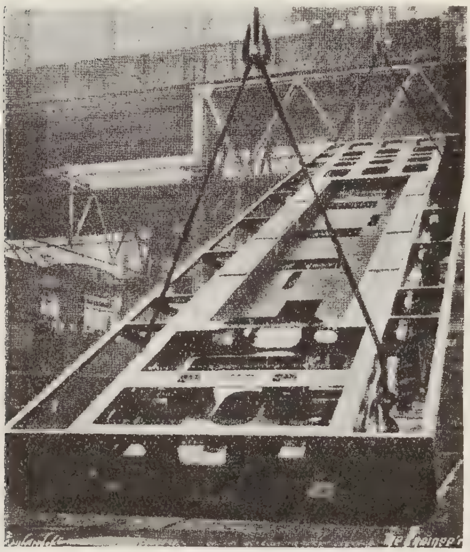


Fig. 2. — Underframe.

bogie are provided with flange lubricators. All the axles have Peyinghaus Isothermos boxes, and those of the driving axles are supported by overhung laminated springs, equalised down each side. The two halves of the locomotive are connected together by a single rigid draw-bar, and there are two large side buffers with spherical spring-loaded heads running one inside the other and designed to take all the buffing shocks and at the same time provide a steadying force to counter any oscillations between the two halves of the locomotive.

The cab structure is of all-steel construction, and contains in each half a driving compartment, a generator and switchgear compartment and an engine room. To pass from one engine room t the other there is a central passage b neath the radiator fans, and a vestibu connection with the usual canvas be lows. The roof is curved, and is of lar radius just above the cantrails. Th complete middle portion of the roof removable in order to permit withdr wal of the main engine or any of i principal constituents. In this part the roof and in the adjacent fixed po tions are clerestory ventilators, whic can be opened by air pressure from cock near the cantrail, and thus i crease the ventilation of the engi room and generator compartment du ing hot weather.

Between each driving position ar the end plate of the locomotive is a 12 cell cadmium-nickel starting batter which has a capacity of 150 amper hour in each half. The battery is qui shut off from the driving cabin exce for two vents which project through th top plate. The ventilation of the batte box is direct from outside, and lar hinged inspection covers are fitted the front and sides. Below the drivi control desk and close to the battery a two air reservoirs of 3 cubic feet eac The extremes of weather met with Roumania have required the provisi in the driving cabins of an electric wa heater, a foot warmer, a window wa mer to prevent the formation of ice, a a cooling fan.

A comprehensive Westinghouse bra ing system is fitted to the locomoti The main constituents are an automat brake operating two blocks a wheel the driving and bogie wheels, and a r gulating brake operating on the drivi wheels only. There is also a hand bra applying the blocks on the drivi wheels, and, finally, a special air bra is used at a low pressure in conjuncti with the air sanding apparatus, its fun tion being just to hold the drivi wheels from slipping when starting wi the maximum current. This equipme was considered necessary in view of t

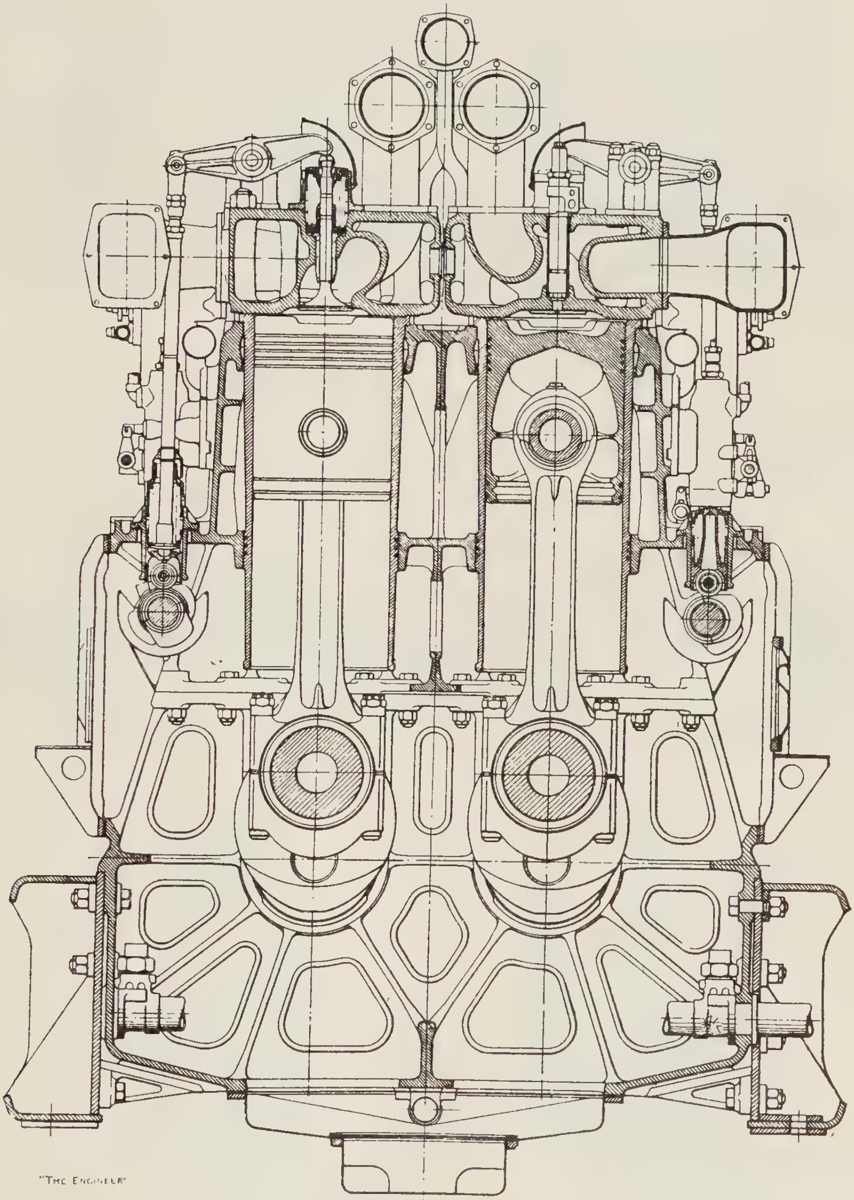
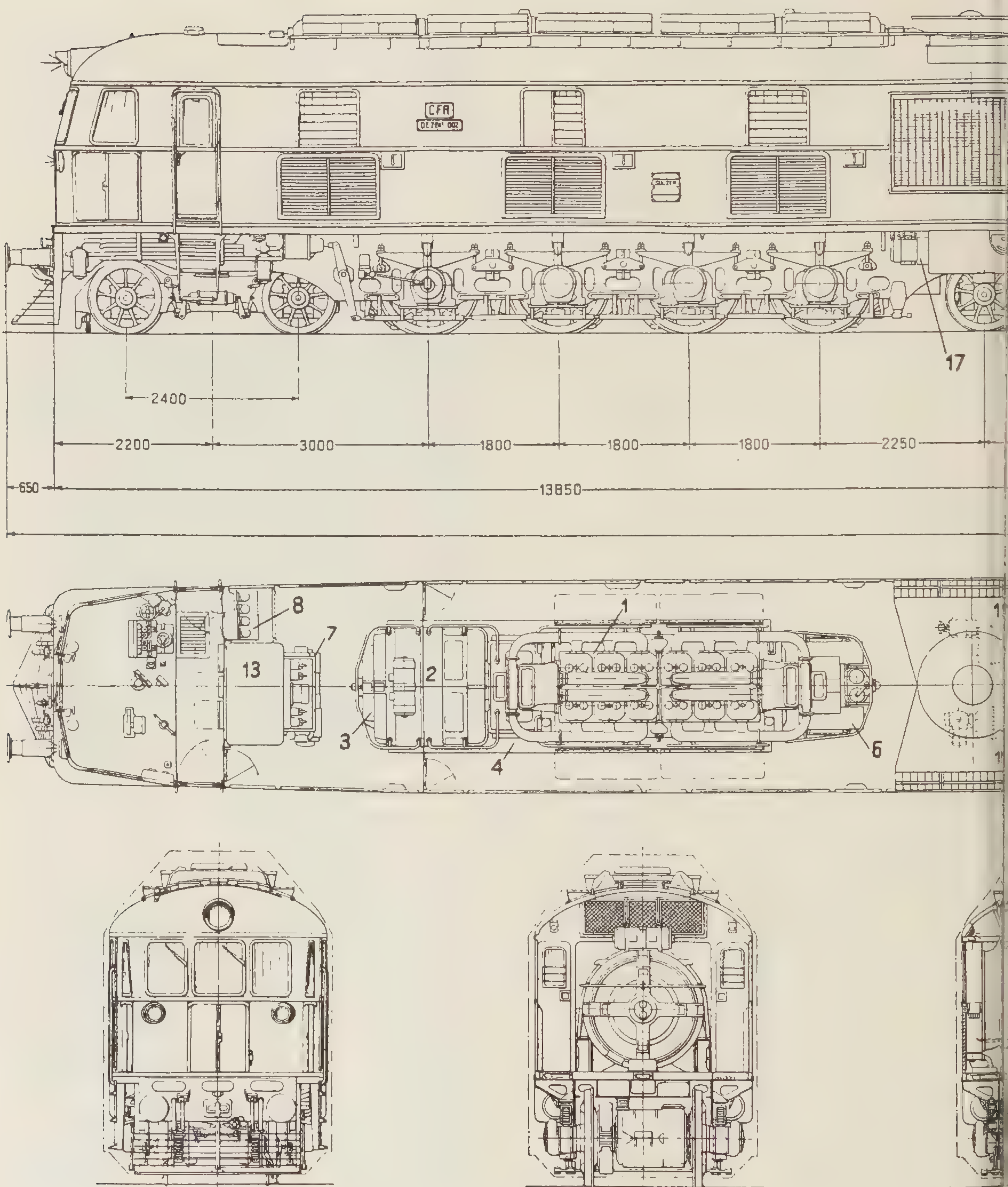


Fig. 3. — Cross section of 2 200-H.P. engine.



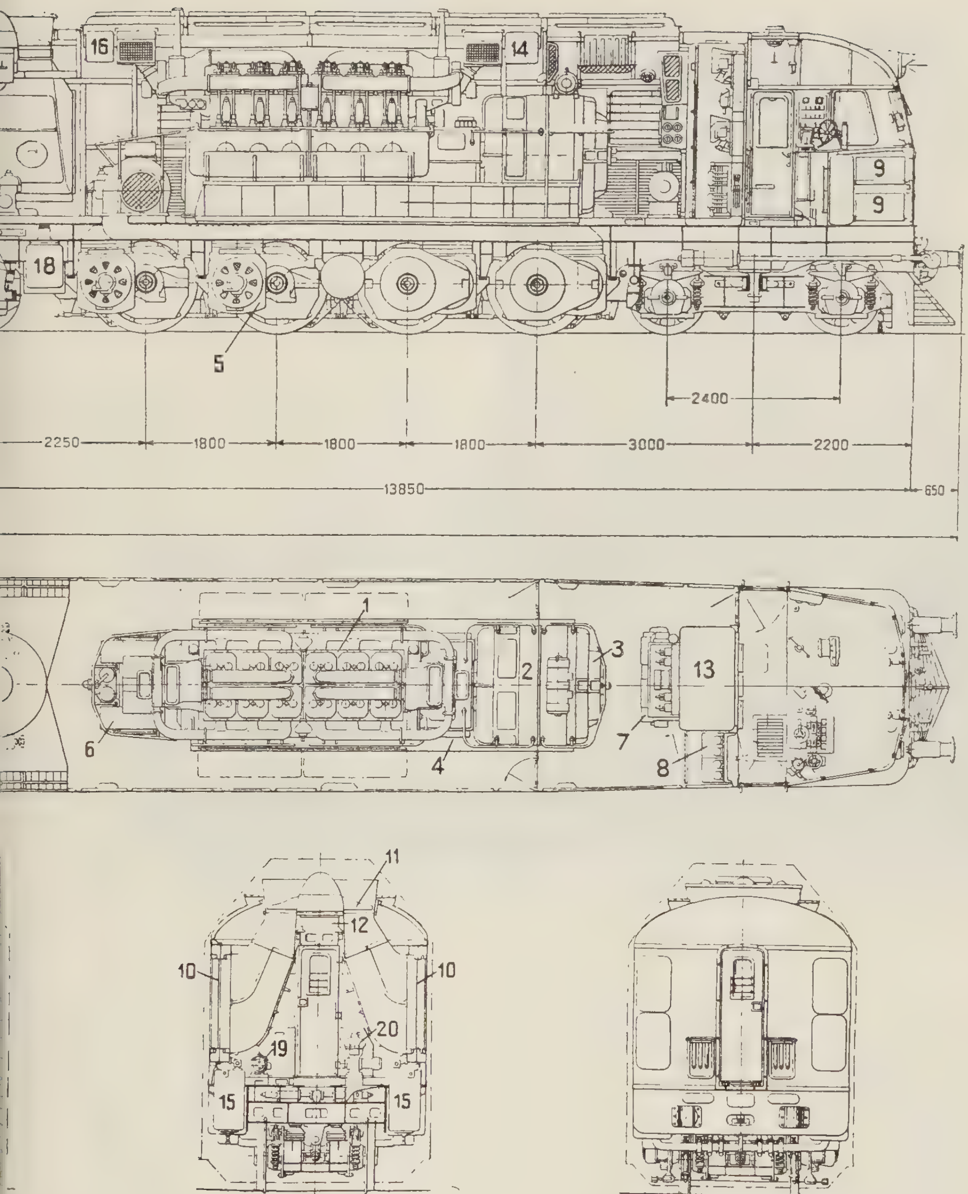
1. — Main engine.
2. — Main generator.
3. — Auxiliary generator.
4. — Engine-generator carrying frame.

5. — Traction motor.
6. — Traction motor blowers.
7. — Brake air compressor.
8. — Electrical contactors and relays.

9. —
10. —
11. —
12. —

4 400-H.P. articulated oi

Sulzer Brothers, Lon



ver.

or.

13. — Main fuel tank.
14. — Service fuel tank.
15. — Main water tank.
16. — Auxiliary water tank.

17. — Cooling water pump.
18. — Lubricating oil tank.
19. — Lubricating oil pump.
20. — Lubricating oil separator.

tive for Roumania.

aur, Engineers.

high starting tractive effort of 80 000 lb., and the maximum factor of adhesion of 4.25. With the automatic system in operation the braking force is 77 per cent. of the weight on the driving axles plus 60 per cent. of that on the bogies. The truck wheels are unbraked. Air is supplied by two Oerlikon motor-driven compressor sets, each with a delivery capacity of 56 cubic feet a minute. With the exception of the cross rods, all the brake rigging and the brake cylinders are outside the frames, and particular trials on the Stein-Säckingen line were made before the finished locomotive was taken to Winterthur for the more detailed trials, extending over four days, between Winterthur and St. Gallen.

Power equipment.

The two oil engines — figures 3, 4, 7 and 9 — used are of the pressure- charged four-stroke twin crankshaft type, and the design was evolved at Winterthur in collaboration with the St.-Denis works of the French Sulzer Company. The

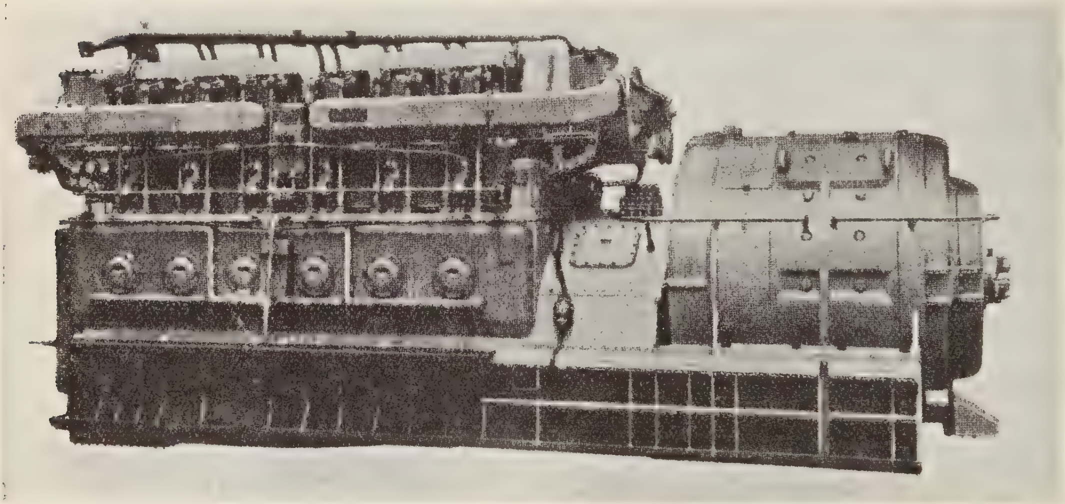


Fig. 4. — 2 200-H.P. engine and generator.

attention has been paid to accessibility, with the result that all the blocks and rigging can be adjusted without the necessity of getting into a pit.

The complete mechanical portion of the locomotive was built at the Cassel works of Henschel and Sohn A. G., and from there was taken on its own wheels to the erecting shops of Brown, Boveri and Co., at Munchenstein, near Basle. Here the engines and electrical equipment were installed, and preliminary

first engines of the type were built at St.-Denis and applied to the P. L. M. Railway's express oil-electric locomotive built last year. Within twelve cylinders, 310 mm. bore by 30 mm. stroke (12.2 in. by 15.4 in.), is developed an output of 2 200 B.H.P. at 700 r.p.m. The characteristics at this speed are : brake m.e.p., 115 lb. per square inch; piston speed, 1 795 ft. per minute; weight, 21 lb. per B.H.P. Actually, a top output of 2 500 B.H.P. at 700

.p.m. has been attained without diffi-
ulty, and with a fuel consumption of
ess than 0.38 lb. per B.H.P.-hour. The
onsistently low fuel consumption over
he usual working range, as shown by fi-
ure 8, is a normal feature of well-de-
igned pressure-charged engines, but the
ctual consumptions in this example are
ery low, the minimum at the second
ngine speed — 485 r.p.m. — being only
.346 lb. per B.P.H.-hour.

Individual Bosch fuel pumps, driven
irect by the main cam shafts, deliver
he fuel at a pressure of about 4 000 lb.
er square inch through Sulzer atomi-
ers set in the centres of the cylinder
eads. All the fuel lead pipes are of the
ame short length; easy adjustment of
he maximum cylinder pressures is thus
ossible, and if a pipe should break the
orresponding fuel pump can be put out
f action without stopping the engine.

Combustion and scavenging air is sup-
lied by two Büchi exhaust gas turbo-
hargers on each engine. A pressure
harging group supplies the three cylin-
ers in each bank adjacent to it, and is
riven by the exhaust gases from the
me three cylinders. For the scavenging
fect the inlet and exhaust valves are
pen simultaneously for a part of the
roke, so that an exceptionally clear ex-
aust is obtained, the valves and pistons
e kept cool, and the heat to be taken
by the cooling water is not increased
mpared with an unsupercharged en-
ne of similar dimensions and speed.
e charging pressure is about 4 1/4 lb.
r square inch at full load. Air is drawn
at the sides of the locomotive and is
ssed through filters before reaching
e pressure chargers.

The crank case is a single-piece steel
sting, which includes stirrup-shaped
in bearing supports and housings for
bearings of the two step-up gear
eels of the generator drive. The cy-
der blocks are also of cast steel, and
two in number; each comprises
ee cylinders from both banks and is

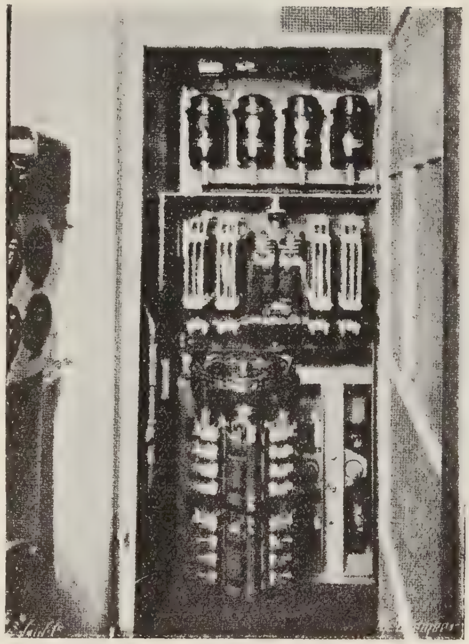


Fig. 5. — Contactors and relays.

welded to the other portion. Bolts are used for the connection of the cylinder blocks to the crank case. Each cylinder has a replaceable wet type liner inserted, and the top flange of this is between the cylinder head and the cylinder block. The cylinder heads are formed of separate iron castings and carry one inlet and one exhaust valve and the central injection nozzle. The valves are driven through the usual kind of rocker, with double springs. There is a separate gear-driven nickel steel cam shaft for each line of cylinders, and they are carried in seven two-piece bronze bearings on the cylinder block. The cams themselves are keyed to the shafts.

Forged aluminium alloy pistons are used and weigh about 100 lb. each; they carry five pressure and two scraper rings and a case-hardened hollow steel gudgeon pin, which is fixed in the side

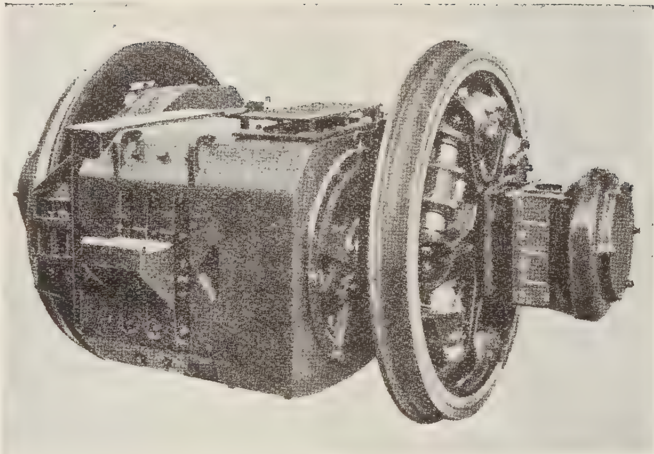


Fig. 6. — Traction motor and wheels.

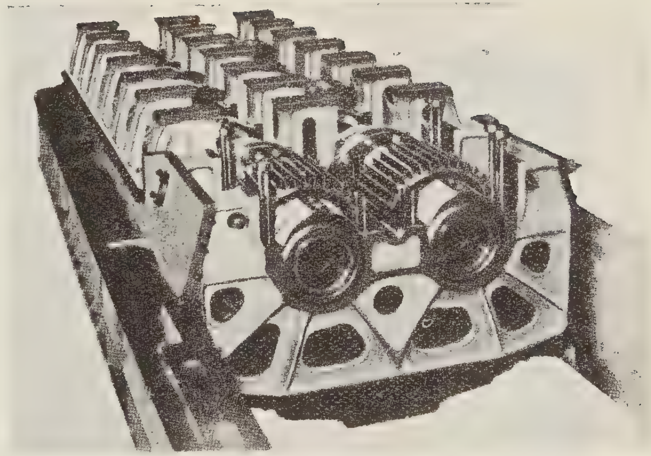
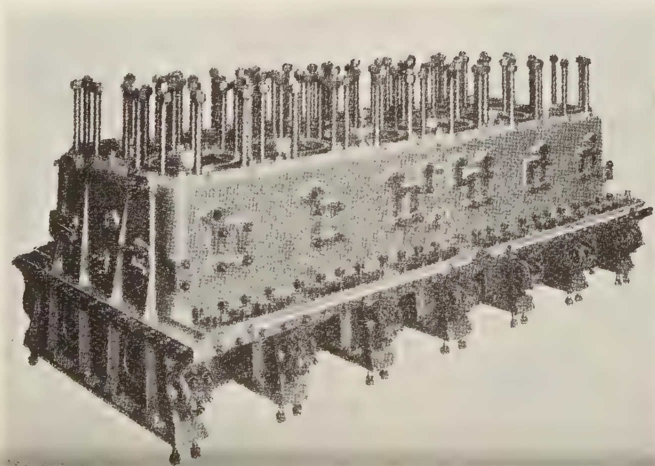


Fig. 7. — Crank-case assembly.



sses. The connecting-rods are of I ction nickel-chrome steel and have ır-bolt big ends with replaceable bron- shells lined with white metal. A hole drilled up the centre of the rod to lead to the bronze gudgeon pin bearing. e crankshaft is a single-piece forging the usual Sulzer brand of special car- n steel, and is hollow bored in both ıs and shaft. The seven main bear- ;s of each shaft have steel shells with ite metal linings over the whole sur- e. At one end of each shaft is a dyn- ic vibration damper, which has effec- ely countered all resonance between highest and the lowest working eeds, and at the other end is bolted short shaft carrying the primary eel of the generator drive. Lubricat- ; oil is led to the main and big end ırings through passages drilled in the ıft.

Two pumps within the crank case cir- ate the lubricating oil. Each pump is ven by a gear wheel keyed to the nkshaft beyond the vibration dam- . One pump draws the oil from the lecting tank and delivers it through ilter into the forced lubricating sys- ı, and the second pump withdraws hot used oil from the sump and pas- it through the cooler, whence the oil ws to the collecting tank. After any gthy period of rest oil is forced to all ts of the engine by an electrically ven pump; the driving motor of this np receives its current from the start- battery. All the servo-motor pres- e oil systems (governor, pressure rging, protective device, field regul- r) are connected to the cooling cir- t. The oil trough on the engine is nected by a compensating pipe to the tainer lying at a lower level; con- uently, if there is a leakage of oil at place, the level of the oil in the ıgh falls, so that the pump cannot w up any more oil, and through the ılting fall in pressure the governor ɔs the engine. The oil pressure contact is fitted in the forced lubricating system, so that there is sufficient provision against fall of pressure in both circuits. In the same control circuit are two switches, which break the circuit if the temperature of the cooling water or of the lubricating oil should exceed a certain predetermined value. This safety device causes the engine to be shut down if the cooler fan is running too slowly, or not at all, or when the thermostats are not functioning properly. The fuel regulation mechanism is arranged to form a closed driving system for each group of six cylinders connected to the same pressure charger. As long as the charging pressure does not fall below the figure permissible for the load prevailing at the moment the governor keeps the engine speed constant, but if the charging pressure falls through any defect the safety device causes the quantity of fuel injected to be reduced in those cylinders corresponding to the defective pressure charger.

Electric transmission.

The electric transmission system is a modification of the well-known Brown-Boveri servo field regulator type, and embodies Sulzer's form of servo-motor and governor rheostat regulation of the engine output. The control permits of engine operation at four speeds, viz., 380, 485, 625, and 700 r.p.m., and also gives eight controller notches, four of which give variable torque characteristics at a given engine speed.

Advantage was taken of the necessity of a gear drive between the twin crankshafts and the single armature shaft of the main generator to incorporate a step-up ratio of 1.2 : 1, and thus increase the speed of the generator and keep down its size. Each main generator has a one-hour capacity of 1 250 kW., and supplies current to the four traction motors — figure 6 — of the corresponding half of the locomotive. To cope with space limitations, the la-

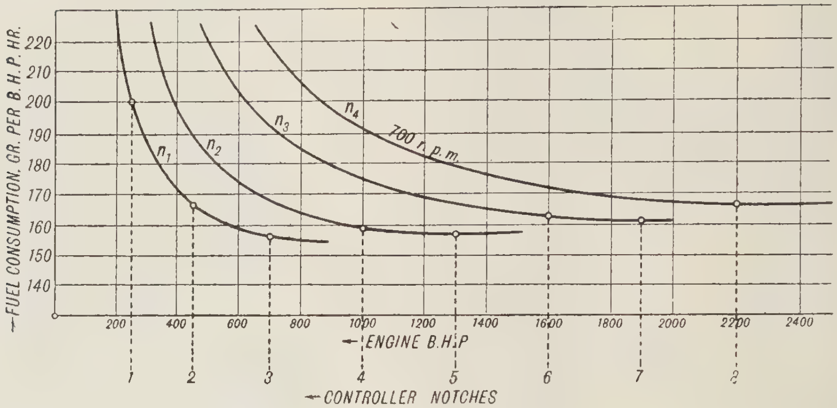
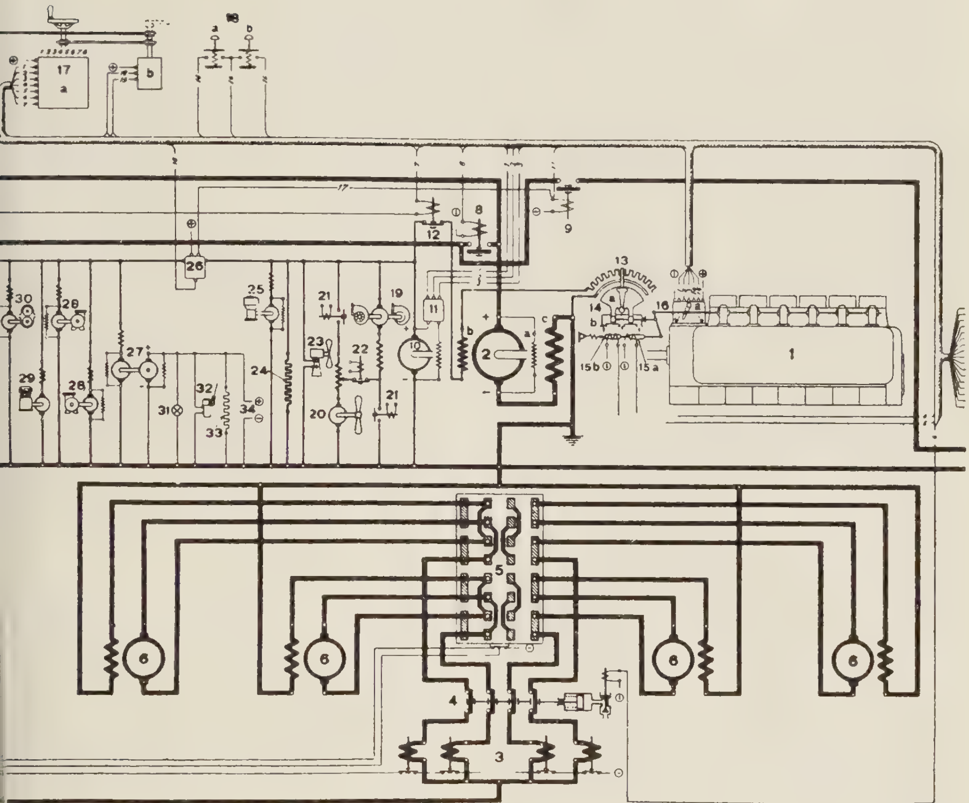


Fig. 8. — Fuel consumption curves.

minations of the armature are fitted direct on to a hollow cast steel member which forms the shaft, and this also saves weight while giving adequate rigidity. The whole generator assembly has been kept short by mounting the commutator on the coupling end of the shaft, so that the rotor of the overhung auxiliary generator could be inserted almost entirely within the rotor of the main machine. A fan, fixed to the main rotor member near the coupling, draws air through the auxiliary and main generators and expels it to the atmosphere through a casing in the floor of the locomotive. Any carbon dust from the commutator brushes is thus removed outside immediately, and, further, if there is any tendency to spark around the commutator, the strong air current makes it difficult for an arc to form between the commutator and the windings. The main generator rotor is supported on a roller bearing to the outside of the 70-kW. auxiliary generator, and also on the neighbouring pinion bearing.

The generator characteristics preventing the overloading of the engine, while permitting a tractive effort as near the maximum as possible over the whole speed range, are obtained by the excitation of the main generator field on three systems, viz., an unregulated shunt winding a, a regulated separately excited winding b fed from the auxiliary generator, and a counter-compound winding c through which flows current from the rotor. The different windings bear such a relation to each other that when the separate excitation is switched off the voltage falls to zero, and when at the moment of starting there is full separate excitation, the maximum permissible tractive effort exists at the rims of the driving wheels. Within a certain range of track speed the output is kept constant automatically, but if the output has to remain constant from the speed at which the normal output of the engine is reached with maximum tractive effort, until approximately maximum speed, then some regulation of the excitation is required, and this is performed by the regulating resistance, 13 in the diagram of main circuits — figure 11.

With the engine running under full load after the train has been accelerated, the pointer $1a$ of the governor is in the position shown, and with the torque magnets $15a$ and $15b$ in the position drawn, the slide valve b of the oil-pressure servo motor 14 is in the closed po



gine.
eed regulator.
ain generator.
unt winding.
parately excited winding.
ti-compound winding.
ximum current relay.
ectro-pneumatic isolating switch.
verser.
action motors.
rting battery.
rting switch.
ttery paralleling switch.
xiliary generator.
ltage regulator for auxiliary generator.

12. — Exciter switch.
13. — Field regulating resistance.
14. — Field regulator.
14*a*. — Field regulator vane.
14*b*. — Control valve.
15*a*, *b*. — Solenoid for torque adjustment.
16. — Magnet control lever.
17. — Traction controller.
17*a*. — Main drum.
17*b*. — Auxiliary drum.
17*c*. — Starting drum.
18*a*, *b*. — Starter button for oil engine.
19. — Traction motor blower.
20. — Cooler fan assembly.

21. — Contactor for parallel operation.
22. — Contactor for series operation.
23. — Driver's cab ventilating fan.
24. — Driver's cab heater.
25. — Oil separator.
26. — Battery cut-in and cut-out switch.
27. — Voltage transformer.
28. — Cooling water pump.
29. — Brake air compressor.
30. — Oil pump.
31. — Lighting.
32. — Window wiper.
33. — Window heater.
34. — Control.

Fig. 11. — Diagram of electric connections.

sition. The piston 14*a* is consequently at rest, and the part of the resistance 13 which is switched in is not changed. If the tractive resistance increases, owing, say, to encountering a gradient, the tractive effort is no longer sufficient to allow of the speed being maintained. The train slows down and the tractive effort changes. If the original position of the pointer was to the right of the position as drawn, the engine tends to become overloaded, and the governor pointer 1*a* moves towards 10. The turning of this governor pointer causes the slide valve *b* to move to the right and allows oil under pressure to enter on the right side of the rotary piston 14*a*. This piston turns to the left, and the regulating switch fixed to it brings in part of the resistance 13, and the working is transferred to a new combination of speed and tractive effort. But the action of the servo-motor does not end until the new combination produces full engine load. If there is a reduction in the tractive resistance when running, the governor pointer moves in the direction of 0 and the slide valve 14*b* goes to the left, so that the piston 14*a* is turned to the right and the excitation of the main generator is increased until full engine load has again been reached and the track speed increased.

As in normal service it is neither desired nor required to work the engine at a full load practically all the time, the main drum of the driver's controller — figure 10 — is provided with a number of steps for running at reduced output, as well as with a step for full load at full engine speed. With the reduced output steps the power is regulated, on one hand, by adjusting the speed of the engine to various values which are then kept constant, and on the other hand, by changing the fulcrum of the lever 16 by means of the magnets 15*a* and 15*b*. In running steps 1 to 4 resistances are switched into the circuit of the main generator field 2*b*, in order to obtain uniform graduation of the starting tractive effort.

In the position shown in the diagram, the magnet 15*b* has its armature drawn up against the action of the tension spring, and the lowest point of the lever 16 is pressed into its extreme left position. In this position of the fulcrum the closing position of the slide valve 14*b* corresponds to the maximum quantity of fuel as set by the engine governor 1*a*. If the magnet 15*a* is excited instead of 15*b*, the lowest fulcrum of lever 16 moves somewhat to the right. As the centre fulcrum remains at the same point in the position of equilibrium, the governor adjusts the fuel injection to a smaller quantity. If the magnets are no longer excited, there will be a further reduction in fuel, since the lowest fulcrum of lever 16 goes to the extreme position on the right, and the governor keeps the smallest load constant.

The valves for adjusting the speed and also the torque magnets are controlled from the main drum *a* of the controller 17 — see figure 11. The torques and rotational speeds are co-ordinated in the different controller steps, as indicated in the attached table, so that the tractive effort is graduated uniformly over the whole range of track speed — see figure 12.

The field regulator assembly 13, 1[4] changes in load due to outside circumstances, such as the alteration in the temperature of the main generator windings. When these windings become hot the tractive effort-speed characteristic move down and this causes less load o[n] the engine. The field governor then increases the excitation, so that the desired output is again obtained. Compensation for alteration in the auxiliary load also is given by the field regulator which always works in such a way that the main engine, in spite of fluctuation in the auxiliary requirements, is never overloaded. On the other hand, if there is a reduced call on the auxiliaries, th[e]

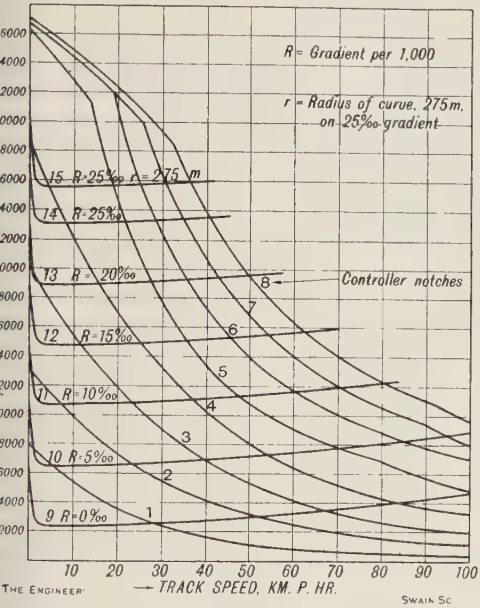


Fig. 12. — Tractive effort curves.

orresponding amount is switched over) the main load. If there is bad com- ustion or a defect in individual cylin- ers, the field regulator reduces the per- iissible output of the engine in propor- on.

Controller step.	*Torque.*	*Speed.*	*Output, B.H.P.*
1	Variable	n_1	Variable
2	"	n_1	"
3	"	n_1	"
4	"	n_2	"
5	M_1	n_2	1300
6	M_1	n_3	1600
7	M_2	n_3	1900
8	M_3	n_4	2200

The general operation of the control stem may be followed from the dia- am of main circuits — figure 11. The verser 5 is operated with the help of e reversing drum *b* of the controller and of the leads 12 and 13. Drum *c* the controller 17 serves for starting e two engines. The front starting con- tor 8 is switched in by means of the lead 8 and the rear starting contactor 8 by means of the lead 9. The leads 8 and 9 are crossed in the control circuit coupling 35. With the help of the starting drum 17*c*, the operating circuit of the charging apparatus 26 is interrupted in the starting position. This circuit leads from the positive pole of the control current source through the charging apparatus 26, the lead 18, the starting drum 17*c*, the lead 10, the coupling 35, the lead 11, the starting drum 17*c* of the other driver's cab, to the negative pole of the control current source. When starting either of the two engines, both sets of apparatus 26 are open, and therefore it is not possible for one auxiliary generator to furnish current for the starting of the other engine. With the charging apparatus open, lead 17 is connected to the positive pole by means of an auxiliary contact. The contactors 9 are therefore closed and the two battery halves are connected in parallel for starting the engines. An interlocking device prevents the two engines from being started simultaneously. The driving motor contactors 4 and the exciting contactors 12 are switched in by the main drum through leads 6 and 7. Leads 1, 2, and 3, controlled from the same drum, serve, on the one hand for operating the speed-regulating valves of the engine, and, on the other hand, for actuating a contact apparatus which adjusts the additional resistances in the field of the auxiliary generator in such a way that the voltage remains approximately constant at all speeds. Leads 4 and 5 serve finally to control the torque magnets 15*a* and 15*b*. The main engines are stopped by pushing the button switch 18, which bridges over the solenoid of an electro-pneumatic valve by short circuiting the leads 14 and 16, or 15 and 16, respectively. The valve then allows air to escape from the stopping cylinder, so that a spring brings the fuel-regulating rods to zero injection.

The traction motors, although of the

form generally associated with nose suspension, are rigidly fixed to the locomotive frame structure, and thus are wholly spring-borne. Both the continuous and one-hour ratings are 290 kw., but the relative voltage and current values are different, and also the speed. The motor torque is transmitted to the wheels through individual axle drive of the cup spring type, with reduction gears having a ratio of 5.5 : 1. The hollow quill surrounding the axle is carried in the cast steel motor casing; round the spider at the driving end is shrunk the nickel-chrome steel gear rim. Roller bearings are used for the armature shafts and plain bearings for the axle supports. The motors are force ventilated, and there is a motor blower group in each half of the locomotive.

The auxiliary services are partly connected directly to the battery, and can therefore be operated when the main engines are at rest, and partly are fed from the auxiliary generator side of the charging apparatus 26 in the diagram, in which case they operate only when one or both engines are running. Among the engine-governed services are the traction motor blower sets, the radiator fans, the driving cabin fans, and the oil separators 19, 20, 23, and 25 respectively in the wiring diagram. On the battery side of the apparatus are connected the voltage transformer group 27, the cooling water pump set 28, the brake compressor set 29, and the priming oil pump group 30. On the secondary side of the voltage transformer, at a tension of 24 volts, are the lighting switch 31, window wipers 32, window heaters 33, and the control circuits 34.

Test performances.

Trials on the Winterthur and St. Gallen line of the Swiss Federal Railways with trailing loads of 300 and 500 tons by no means extended the locomotive, although there are up gradients as steep as 1 in 83. With 300 tons behind the drawbar, the locomotive ran the 17 1/2 miles of gently rising and almost continuously curved line from Winterthur to Wil in 21 min. 20 sec., inclusive of a permanent way slack from 50 to 22 m.p.h., and with a top speed of 62 m.p.h. From Wil to St. Gallen, uphill for two-thirds of the way, and with gradients of 1 in 83 to 1 in 100, the start-to-stop time for the 18 1/2 miles was 23 min. 47 sec. the top speed of 62 m.p.h. being attained near Gossau. On another run this distance was covered in 24 min. 5 sec. including a signal check to 25 m.p.h. when on the bank. The acceleration out of Wil, going uphill, was from rest to 19 m.p.h. in 35 sec.; to 25 m.p.h. in 46 sec.; to 32 m.p.h. in 58 sec.; to 37 m.p.h. in 69 sec.; to 45 m.p.h. in 89 sec. and to 50 m.p.h. in 97 sec. On the return trips from St. Gallen, one engine working at a fractional output was sufficient for the power requirements with a 300-ton train. The fuel consumption on the up gradient sections averaged 8 gr. per tonne-kilometre (13 gr. per ton-mile), and on the downhill journeys 4.5 gr. per tonne-kilometre (7.3 gr. per ton-mile). Under the worst conditions the starting currents through the main generators did not exceed 2 500 amperes each. Running along undulating line at speeds of 53 to 57 m.p.h. required 900-1 000 amperes at 700-750 volts. Although these trials did not form a severe test for the power and transmission equipment, the nature of the line gave a very fair indication of the behaviour of the locomotive as a vehicle. The riding qualities were smooth at all speeds up to the maximum permissible rate of 62 m.p.h., at all points on the locomotive, except perhaps near the centre joint, where there noticeable side-to-side oscillations and shocks on both straight and curved track at speeds above 40-45 m.p.h.

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Diesel locomotive with direct drive,

by Dr.-Ing. SCHRADER,
Regierungsbaumeister, Cologne-Mülheim.

(From *Glasers Annalen.*)

A study of the problem of direct drive for diesel locomotives, the solution of which is embodied in the 4-4-4 experimental locomotive built by the Humboldt-Deutzmo- ren A. G. Schematic representation of this locomotive, the driving mecanism of which similar to that of 3-cylinder simple expansion steam locomotives; its method of opera- n; characteristic diagrams. Control of the new diesel locomotive, as simple as that the steam locomotive. Results of practical trials obtained up to date in regular service the German State Railways.

Vhilst the diesel engine, thanks to its 1 thermal efficiency, the simplicity ts operation, and the small space it es up, is particularly suitable for the pulsion of vehicles, it is, on the other d, well known that it possesses the uliarity, inherent in its principle of king, of only being able to work after imber of revolutions notably different 1 zero, and afterwards to develop a imum torque which is appreciably stant. It is on account of this pecu- ty, which cannot be reconciled with vay train services, that is has only possible to apply the diesel engine rectly to locomotive drives. So long is only a question of low, or even edium, powers, it is still possible to pt the complications, increase in ht, and the operation and mainten- costs, which are the inevitable dis- ntage associated with indirect diesel missions. But the increased ex- es resulting in the case of the large l-electric locomotive, which is the nt-day protagonist of diesel trans- ons, are only justified, apart from dvantages it offers over other types comotives, by the fact that it has been possible up to be present to ve the ideal represented by direct on diesel locomotives in spite of the very advanced studies and repeated trials which have been carried out by large firms, both German and foreign.

The Humboldt-Deutzmotoren A. G. has succeeded during the last few years in perfecting an entirely new system, which is based on an extremely simple principle which overcomes the aforementioned disadvantages, and which by means of a method of starting and additional feeding connected with the normal diesel running, enables a direct drive of greater flexibility to be used on the diesel locomotive.

We do not propose to enter here into the details of the old trial designs which proved unsuccessful. In this respect all that need be said is, briefly, that the solution of the direct-drive problem does not consist in running the locomotive under load, by means of a more or less complicated, and consequently undesirable, auxiliary device, up to the number of revolutions necessary for ignition, but in achieving a continuous tractive effort curve affecting the shape of a hyperbola. Furthermore — as has been noticed — the abrupt change to combustion causes damage which is often serious, to the diesel engine, which engine is itself necessarily light for constructional reasons. This abruptness also causes frequent

Fig. 1. — Diesel locomotive at head of a train of 265 t. (261 Engl. tons).

troubles, particularly when starting with compressed air, though this is the most convenient auxiliary. Moreover, a locomotive with a standard diesel engine would in any case have to be of larger dimensions than necessary for running conditions on the level, particularly on lines passing through hilly country. Consequently, a gentle, and at the same time progressive, transition, as regards the production of heat, from the wide full-pressure diagram to the normal diesel diagram is essential. Moreover, it is necessary to lay down the condition that starting can be effected under load on up gradients, in view of the fact that the districts for which diesel locomotives of high power are of special interest generally abound in heavy inclines. An auxiliary fulfilling this condition would, according to former principles of working, necessarily become too large to be accomodated as an accessory fitting, and would indeed become a second main engine.

We may mention, in this respect, the remarkable article published in 1931 by

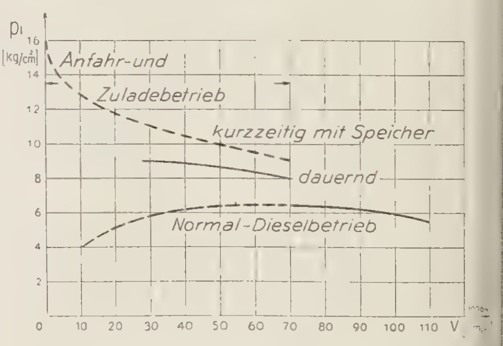


Fig. 2. — Average pressure in cylinder, limited by the adhesive weight and the air feed.

Note. — Anfahr- und zuladebetrieb = period of starting and additional feeding. — Kurzzeitig mit Speicher = a short period with storage bottles. — Dauernd = continuous. — Normale Diesselbetrieb = normal diesel running.

SANDEN and WOHLSCHLAGER (1), who proposed to heat the compressed air to 350° (662° F.) before introducing it into the cylinders of the locomotive and in

(1) Note communicated by « Trilok ». *Organ für die Fortschritte des Eisenbahnwesens*, 1st April, 1931.

cting the fuel. This method was, however, not experimented with either.

The new procedure, applied in the xperimental 4-4-4 diesel locomotive by e Humboldt-Deutzmotoren A.G. (fig. 1) ombines organically, and consequent-, freely and economically, by a special ethod, the power developed in the

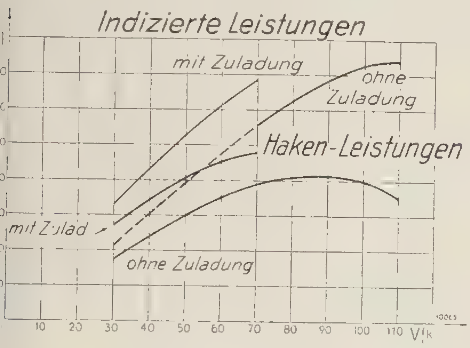


Fig. 3. — Curve of indicated powers and powers at the drawbar hook.

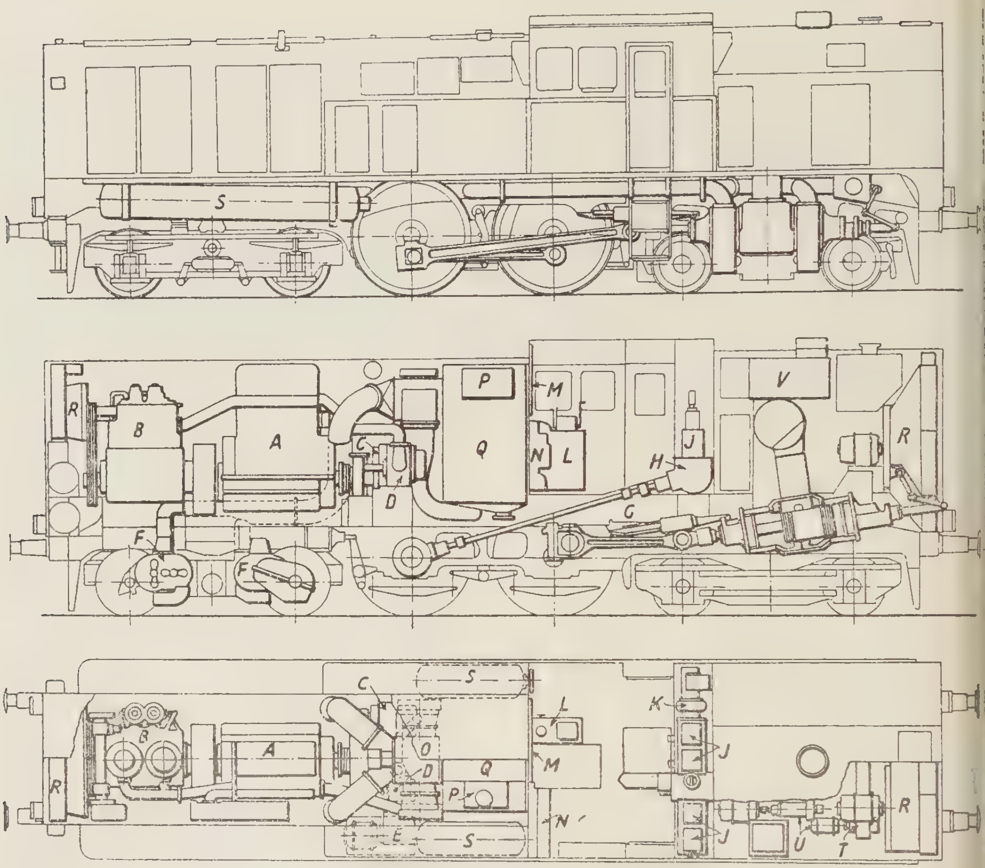
ote. — Indizierte Leistungen = indicated horse-powers. — Haken-Leistungen = powers at the draw-bar hook. — Mit (ohne) Zuladung = with (without) additional feeding.

xiliary apparatus, from zero up to a gh speed, with the power of the main esel engine, directly driving the loco-otive through the whole range of eeds; and, as shewn by figures 2 and the locomotive thus constituted be-mes more powerful, and in addition, ore flexible, than a steam locomotive of milar dimensions. As a matter of fact, like what happens in the steam loco-otive, there is even at high speeds, a rge mean pressure available in the cy-nders which, under running conditions, hilst affording an advantageous reserve tractive effort and at the same time tting no strain on the engine, can be ried as required in such a manner as obtain any particular partial load.

The evolution, method of operation, d the general arrangement of the loco-otive have already been described by . A Langen (2). It will therefore suffice here to give a brief description of the new process, in order to deal at greater length with the results obtained in service up to date.

Figure 4 is a schematic representation of the new type of diesel locomotive with direct drive, an explanatory footnote giving the letters designating the various parts. Starting is effected by introducing compressed air into the three diesel cylinders, which are of the two-stroke, double-acting type, arranged like those of three-cylinder simple expansion steam locomotives. The compressed air is supplied by a three-stage compressor, driven by an auxiliary diesel engine, and absorbing up to a maximum of 150 H. P. The power required for starting by the auxiliary equipment is therefore small in relation to the maximum horse-power of 1 200 at the locomotive wheel tread. As soon as the compressed air reaches the cylinders and has entered the first working spaces and a driving pressure is obtained able to overcome the total resistance of the locomotive and of the vehicles, the train begins to move, and the locomotive at the same time drives its fuel pumps. However, at first only the lower pressure pumps act on the injection valves fitted in the cylinder heads, in such a manner that the fuel oil, finely atomised, arrives, during a fairly long admission period, in the cylinders in action, ignites on a white hot spiral which is heated electrically, and burns. This starting which is primed by a few ignitions from the mixture of the compressed air and fuel takes place — again exactly as on the steam locomotive — with the reversing gear right home, in such a manner that, for each position of the crank, a sufficient starting effort is obtained with reliability. Afterwards,

(2) Dr. A. LANGEN : » Die Diesellokomotive mit direktem Antrieb » (The diesel locomotive with direct drive). *VDI* — Forschungsheft (research volume) 363, Berlin, 1933. An extract from it was published by the author in *Z-VDI*, Vol. 77, p. 1287).



(From *Diesel Railway Traction*, supplement to *The Railway Gazette*.)

Fig. 4. — Layout of equipment on locomotive.

Principal data :

Number of cylinders	3	Total wheelbase	10.750 m. (35' 3 1/4")
Dia. of cylinders	380 mm. (14 15/64")	Rigid wheelbase	2.500 m. (8' 2 1/2")
Stroke of piston	600 mm. (23 5/8")	Total weight	87 t. (85.6 Engl. tons)
Maximum hourly speed	110 km. (68.3 miles)	Adhesive weight	36 t. (35.4 Engl. tons)
Dia. of driving wheels	1.750 m. (5' 8 29/32")	Fuel capacity	2 t. (1.87 Engl. tons)
Length over buffers	14.550 m. (47' 9")		

Legend :

A. Auxiliary diesel engine.
B. Compressor.
C. Generator.
D. Supercharging blower.
E. Auxiliary scavenging blower.
F. Main scavenging blower.
G. Cardan shaft.
H. Driving shaft.
I. Fuel pumps.
K. Oil-operated control of compressed air.
L. Control panel.
M. Instrument board.
N. Electrical switch box.
O. Valve for changing the direction of the scavenging air
P. Sandbox.
Q. Fuel tank.
R. Front and rear radiators.
S. Air bottles.
T. Electric fans
U. Cooling water pumps.
V. Exhaust.

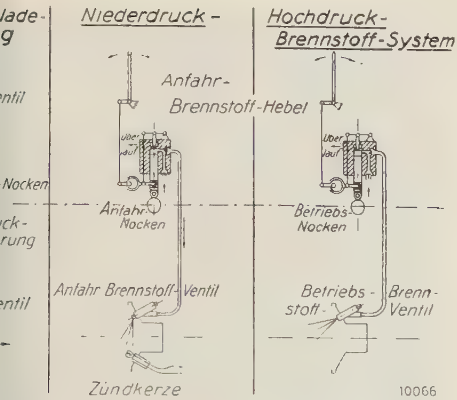


Fig. 5. — Control diagrams.

Explanation of German terms:

off-Hebel = starting fuel lever. — Anfahr-Brenn- = starting fuel valve. — Anfahr-Nocken = starting hr- und Zulade-Luftregelung = control of air for additional feeding. — Betriebs-Brennstoff-Ventil = alve. — Betriebs-Nocken = normal service cam. — = throttle. — Hochdruckluft = high-pressure air. n-Nocken = cam for graduating the air supply. — air outlet valve. — Niederdruck-Hochdruck-Brenn- = low and high pressure fuel supply system. — rung = oil pressure control. — Zylinder-Deckel = .

order to husband the air, the reversing r is moved over towards the back r, and as, by reason of this, the risk kidding is lessened, the wiredrawing the compressed air by the regulator educed. With a suitable injection of , the admission of which is only con- ed in the first place by means of lever controlling the fuel supply dur- starting, the standard fuel pumps not producing a sufficiently high pres- to induce injection through the die- uel valves themselves, a diagram of k is obtained, which is not as wide, is a little higher, as in a steam en- In proportion as the speed rises the tractive effort decreases slowly, air and fuel admissions continue to educed, and also the auxiliary fuel tion, particularly when a slight co- ng of the exhaust gases indicates the normal service valves are also ng into play and are injecting fuel.

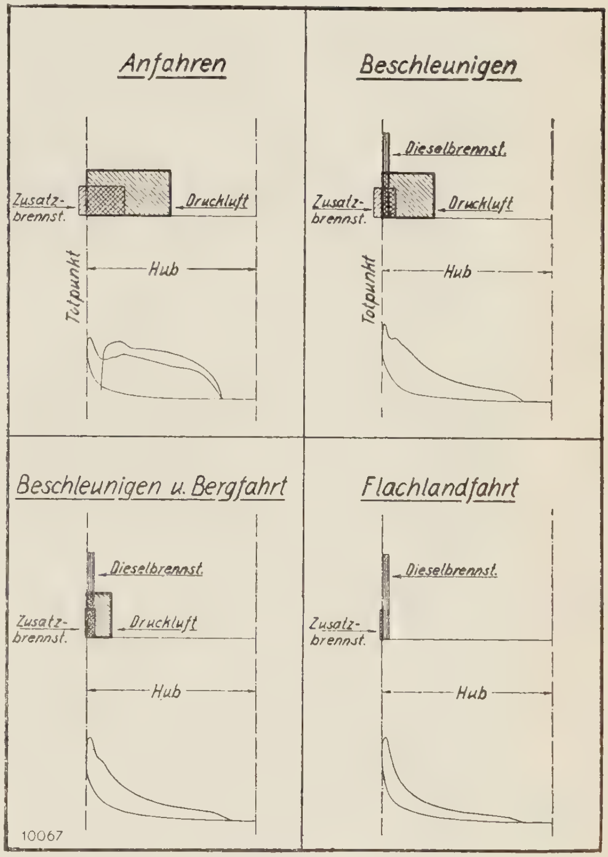


Fig. 6. — Admissions to cylinders and corresponding diagrams of work.

Explanation of German terms:

Anfahren = starting. — Beschleunigen = acceleration. — Beschleunigen u. Bergfahr = acceleration and running up gradients. — Druckluft = compressed air. — Flachlandfahrt = running on level. — Hub = stroke. — Totpunkt = dead centre. — Zusatzbrennst. = supplementary fuel.

At the same time, the diagrams of work continuously diminish in surface, without there being any appreciable change in the pressure points, seeing that the proportion of compressed air corresponding to each stroke and with it the quantity of oil capable of being burnt in the cylinder decreases as the speed increases. This condition of working

that will be called « additional feeding », is maintained up to a speed of about 70 km. (43.5 miles) per hour, and afterwards the normal diesel tractive effort is sufficient to continue to accelerate the train and to increase the speed to a high figure. It will be seen (fig. 3) by the differences existing between the period of additional feeding and the normal power, that the power taken by the engine for driving the compressor is more than made good by the increased amount of fuel injected.

The object of figures 5, 6 and 7 is to shew how simple the new diesel locomotive is to drive, and its complete analogy with the steam locomotive. The steam regulator corresponds with the air throttle, and the notching up of the valve motion with the longitudinal movement of the air cam for different lengths of admission. There are no other new parts except the two fuel levers which are operated, as shewn in figure 6, in order to obtain additional or normal quantities of fuel. Figure 7 shews the driver's cab : the air throttle is closed, the air distribution is in the neutral position, and the supplementary fuel lever set for minimum admission; all that the driver has to do is to operate the main fuel lever which he merely closes in order to bring the locomotive to a standstill. An important feature is that the harmful effects due to the reciprocating parts of steam locomotives running with the regulator closed (3) do not occur on the direct-drive diesel locomotive, seeing that the pistons are always held by the cushioning effect from the compression, not only when running under load, but also when coasting.

By reason of the 4-4-4 arrangement of the wheels, the running qualities of the

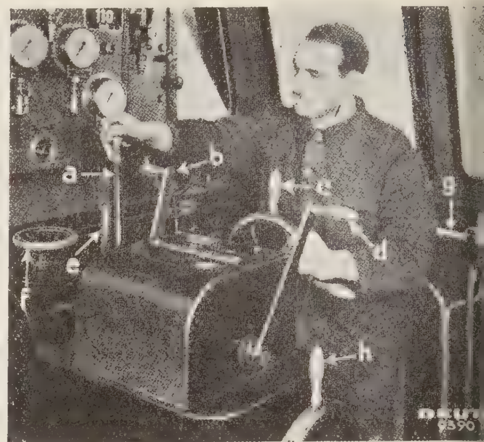


Fig. 7. — Driving cabin of locomotive.

a) Main fuel lever, used only for control on level a medium and high speeds;
b) Supplementary fuel lever operated at starting an during acceleration, as well as on the up gradient (concurrently with *a*) for accelerating and climbing gradients);
c) Hand wheel used for moving the driving shaft fo changing the direction of running and for admitt ing additional air;
d) Additional air throttle;
e) Sandbox;
f) Starter for electrically-driven fans;
g) Supplementary-air pump;
h) Hand brake.

locomotive are equally good in both run ning directions, and this is also the cas as regards the visibility afforded to th driver, so that it is not necessary to tur the locomotive for one or other of thes two reasons.

In order to appreciate the practic data given below about the service give by the new locomotive, it must not b forgotten that this is an experiment engine, the object of which is to enabl trials to be carried out with the ne system and with the locomotive whic is the practical realisation of the ne system, and, as far as possible, to d monstrate the advantages accruing fro it. It is therefore fitting to state befor hand that the general arrangement the direct-drive diesel locomotive ca be still further appreciably simplifi and improved for practical purposes.

(3) K. GÜNTHER : « Dampflokomotiven für hohe Fahrgeschwindigkeiten » (Steam locomotives for high speeds), *Glasers Annalen*, Vol. 121, Part 7). See also *Bulletin of the Railway Congress*, November 1938.

ıs has already been briefly stated (4), new system has proved its worth in completely satisfactory manner. Up date, this locomotive has run well r 40 000 km. (25 000 miles), of which rly 16 000 km. (10 000 miles) were recently in regular service on the man State Railways, representing 00 000 locomotive-tkm. (2 020 000 lomotive-ton-miles). For the purpose of se practical trials, a passenger local in service was chosen, with stops ocring on an average every 5 km. (3.1 es), the problem of direct drive for sel locomotives being less concerned h normal running than with the start- periods which precede such runs. was under these conditions that the -4 diesel locomotive, having an adhee weight of only 36 t. (35.4 Engl. tons) l a total weight of 87 t. (85.6 Engl. s), running on week days from Cone to Cleves and back (250 km. = 155 es), worked the same service as the ndard P.8 steam locomotive, which is % heavier, and has an adhesive weight 51 t. (50.2 Engl. tons). In the last few eks of the whole trial period, the ıbles, insignificant in themselves, ch had at the first onset caused slight urbances in the service, did not re-. It was only at the end that the main venging blowers, driven off the axles he rear bogie, gave rise to difficulties. se Roots blowers, which are very senve, had previously failed to withstand hard working conditions due to their tion on the bogie, and had been inciently repaired, so that in every the trial runs had to be carried out a shortage of scavenging air; there- the results obtained in service, from point of view of the powers develop- nd of the consumption figures, must considered as all the more satisfac-.

hilst this insufficiency of scavenging air was being remedied in the workshops, the opportunity was taken at the same time of checking over the axleboxes and brasses, and it was ascertained that as the result of the liberally calculated dimensions, the wear on the rubbing surfaces did not exceed a very reasonable limit, in spite of the fatigue being slightly higher than that found in the same parts of steam locomotives. The metal in these brasses had stood up very well, and moreover, in service, the number of cases of hot bearings was not excessive.

In the previous trials runs, it had not been possible to undertake a complete series of measurements of the fuel consumption in terms of the speed and load, because, particularly at the low and medium speeds, the working conditions could not be maintained long enough under a heavy partial load or under full load by the braking of the carriages, either by compressed air or by hand. The practical trials furnished consumption figures taken under all service conditions, and from this point of view, the new diesel locomotive shews up very well as compared with the steam locomotive, which has been undergoing evolution and improvement for a whole century; as a matter of fact, it only consumed, for the same journey and the same kind of service, 1/3.6 of the amount of heat, or by reason of the higher content in specific energy of the gas-oil, about 1/4.8 only of the weight and volume of fuel, and finally, taking into account the consumption of water by the steam locomotive, about 1/35 of the whole of the supplies.

With regard to measuring the fuel consumption in terms of the load and the speed, this will have to be reserved for the runs which are to be carried out with the German State Railways' dynamometer car.

The tractive efforts at the drawbar hook of the 4-4-4 diesel locomotive vary, as shewn by the diagram, figure 8, in

(4) *VDI-Z*, Vol. 81, No. 20, 15th May, 1937, 5.

which we have again a comparison with the P. 8 steam locomotive. Obviously the diesel locomotive cannot vie with the steam locomotive, which is 50 % heavier, as regards the continuous tractive efforts in the lower region of the speeds. The continuous tractive efforts with additional feeding which are here shewn for the diesel locomotive require, like the corresponding powers in figure 3, to be

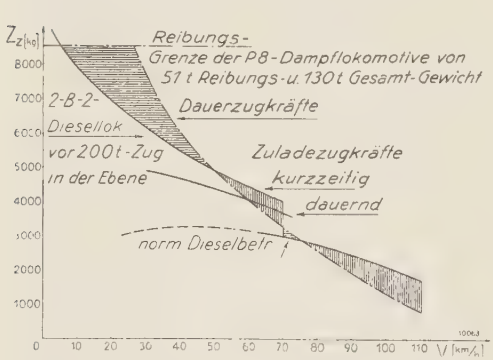


Fig. 8. — Comparison of the tractive efforts of the 4-4-4 diesel locomotive and the P.8 steam locomotive.

Explanation of German terms:

Diesellok. voor 200 *t* Zug. = diesel locomotive hauling a 200 t. (197 Engl. tons) train. — Reibungsgrenze der P. 8 Lokomotive... = adhesion limit of P. 8 locomotive of 51 t. (49.2 Engl. tons) adhesive weight and 130 t. (128 Engl. tons) total weight. — Dauerzugkräfte = continuous tractive efforts. — Zuladezugkräfte = tractive efforts with additional feeding. — Kurzzeitig = for a short period. — Dauernd = continuous. — Norm. Dieselbetr. = normal diesel operation.

checked by means of the dynamometer car, but the value indicated may be considered as correct. However, on the level, and particularly with light trains, the diesel locomotive, thanks to the smaller mass it presents for acceleration, and to the simultaneous use of compressed air for additional feeding when starting, is not inferior to the P. 8 steam locomotive, but even beats this latter. In trial service, when hauling an average load of 150 t. (147.6 Engl. tons), it succeeded in remaining well within the timings for the journey laid down for the P.8. steam locomotive. On account of the six-wheeled coaches, the speed of the local trains was restricted to 85 km. (52.8 miles) per hour. The superiority of the diesel locomotive therefore shews up to better advantage in the neighbourhood of its maximum speed, as shewn in figure 8.

On the whole, the direct drive applied to the diesel locomotive is particularly suitable for high speeds [5]. However, the direct-drive diesel locomotive can also be employed for hauling goods trains, provided that a compressor of suitable capacity and a large battery of cylinders is arranged to supply the compressed air necessary for starting the heavier trains. According to the programme to be achieved in each case, it would be an advantage if the compressor could possibly be completely stopped during a certain time. An essential condition is that the range of speeds required of a locomotive shall correspond with a piston speed, the present maximum of which does not exceed 7 m. (23 ft.) per second.

The practical results as regards fuel consumption have already proved beyond all doubt that the direct-drive diesel locomotive, thanks to its high efficiency and incomparable power/weight ratio [less than 65 kgr. (143.5 lb.) per H. P. at 100 km. (62 miles) per hour, in the new design] is especially suitable for long runs, particularly on lines running through regions where there is a shortage of water. The second feature by which, as we have already mentioned, the direct drive diesel locomotive shews its fundamental superiority over the steam locomotive is its natural aptitude for high speeds. GUNTHER's article, which was referred to at the beginning of the present note, explains the difficulties with which steam locomotives have

(5) A. FINSTERWALDER and F. BREDENBREUKER : « Diesellokomotive für Schnellfahren » (Diesel Locomotives for high speeds). *Z-VDI.* Vol. 78, 15th September, 1934. p. 1088.

contend in this respect, difficulties ich are to a great extent eliminated in direct-drive diesel locomotive, and it l moreover be necessary to try to eli- iate such difficulties as subsist, by a dy carried out in common. It is al- dy possible to obtain with a direct ve diesel locomotive, weighing about t. (98.4 Engl. tons), a power at the wbar corresponding to a specific re- ance of about 10 kgr. (22 lb.) per at the speed of 150 km. (93 miles) hour, namely :

$$\frac{0 \text{ to } 300) \times 10 \times 150}{270} = 1\,500 \text{ H. P.}$$

e radius of action of 600 km. (375 es) which is demanded of a locomo- e without taking on fresh service supplies, can easily be more than doubled; and with the direct-drive diesel locomotive the periods of time necessary for the operations preceding and following the runs are shortened to a minimum, etc.

As the German State Railways are building fast diesel-electric railcars of limited capacity, for which they admit the use of the by-products of petroleum, there is every reason to hope that direct-drive diesel locomotives will also be employed in Germany, if only on the same scale as the fast railcars (6).

(6) STROEBE : « Entwicklung und künftige Gestaltung der Verbrennungstriebwagen der Deutschen Reichsbahn ». (Evolution and future design of internal-combustion-engined railcars on the German State Railways). *Glasers Annalen*, 1st October, 1937, p. 116.

[621. 132.3 (.438)]

New Pacific type streamlined locomotive, Polish State Railways,

by Henry MARTIN,
Ingénieur des Arts et Manufactures.

(*Le Génie Civil.*)

The Polish State Railways sent to the Paris International Exhibition a considerable amount of rolling stock, including a streamlined steam locomotive and a number of carriages designed for special purposes.

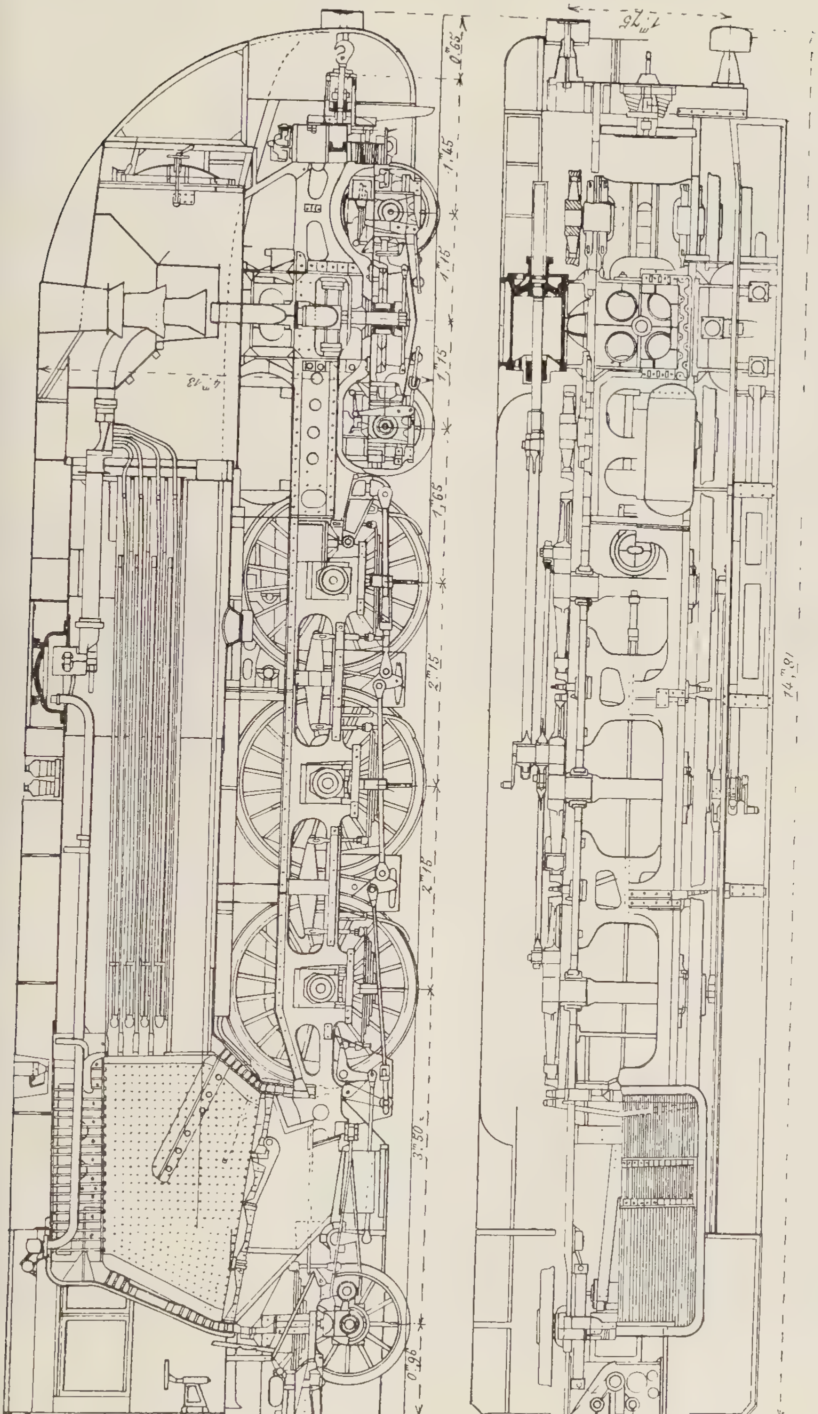
Fig. 1. — Pacific type streamlined locomotive, Polish State Railways.

The locomotive of the *Pacific* type (figs. 1 to 5), designed and built by the « First Locomotive Works of Poland Ltd. », is particularly interesting from the point of view of the special care taken to make its streamlining as efficient as possible.

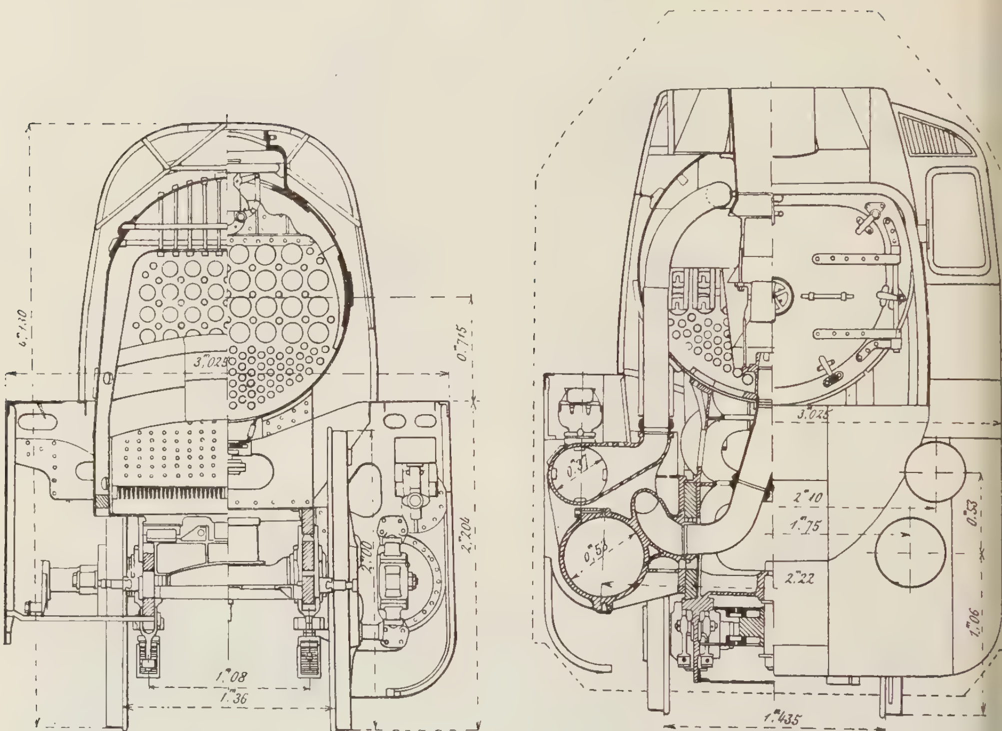
The streamlined shape of the locomotive and tender was, moreover, designed in collaboration with the Aerodynamical Institute of Warsaw, which carried out comparative trials on models of ordinary and streamlined locomotives. The results of these trials, which are shewn in figure 6, proved that the shapes finally adopted for the streamlining ensured a very appreciable increase in powe[r].

This locomotive being intended fo[r] hauling fast 300-ton trains, over fairl[y] flat and straight sections of the railwa[y] at 140 km. (87 miles) per hour, the bui[l]ders considered that a horse-power [of] 1 700 would be sufficient to meet th[e] working conditions.

The top part of the entire length of t[he] locomotive and tender forms a con[ti]nuous surface, the tender being compl[e]tely covered in. The gap between t[he] locomotive and tender, which general[ly] remains open on streamlined locom[o]tives, is also covered in, so as to ensu[re] the continuity of the surfaces. This w[as] arranged without difficulty by placi[ng] the entrance to the driver's cab on t[he] tender instead of between the locom[o]tive and tender. Only the driving whe[els] were left open and uncovered by t[he] streamlined casing, so as to facilit[ate]



Figs. 2 and 3. — Sectional elevation and sectional plan of the streamlined locomotive.



Figs. 4 and 5. — Half cross sections of the locomotive : through the firebox, through the tube-nest, through the cylinders, and half front view.

the examination of the motion during stops of short duration.

On the front of the locomotive, near the chimney, a recess is arranged in the streamlined casing so as to form a passage along which the air is forced in such a manner as to drive the exhaust steam upwards. This arrangement takes the place of the side screen plates which have nowadays come into general use on locomotives.

Moreover, the streamlining in front of the locomotive was so designed as to create a vacuum above the chimney, the object being to improve the draught.

The driver's cab, which forms a closed-in space, has of course to be specially ventilated. Special ventilating devices are fitted above the front cab windows, namely, on the sloping walls of the cab, where there is a sufficient excess of pressure to force the air inside.

As has already been stated, the tender is completely covered in. An opening was, however, arranged in the roof through which the coal is loaded. This opening is closed by two flaps which are moved either towards the front or rear according to whether the front or back part of the coal bunker is being refilled.

The water tanks are filled through inlets, fitted with covers, arranged in the tender side plates, over a length of 3 m. (9' 10 1/8").

A number of apertures (fitted with cover plates which normally are kept closed) are arranged in the streamlined

ıngs of the locomotive and tender, to ›rd access to the various parts requir- maintenance or frequent examin- ›n.

'rame. — This *Pacific* locomotive is of two-cylinder simple expansion super- ted type, and therefore the motion is simple as possible.

'he cylinders, which are arranged la- ılly, on the centre line of the bogie ıich is also that of the chimney) ;. 4), drive the intermediate coupled eels.

'he main frames are 80 mm. (3 1/8") hickness, and are connected by stays he type adopted by the Polish State lways.

'he axles of the driving wheels run in ›boxes fitted in guides having forced l lubrication, the oil being fed into back part of the box. The driving ›els are 2 m. (6' 6 3/4") in diameter, the bogie and bissel truck wheels are ›ectively 1 m. (3' 3 3/8") and 1.200 m. 11 1/4") in diameter.

'he rigid wheelbase is 4.300 m. ' 1 5/16"), whilst the total wheelbase 1.750 m. (38' 6 19/32").

he cylinders have a diameter of mm. (20 7/8"), the piston stroke ıg 700 mm. (27 1/2").

he valve motion, of the Walschaerts ', is actuated by piston valves having ameter of 280 mm. (11 1/32"), with aximum cut-off at 80 %. The cross- l, of the double-bar type, is fitted ı forced feed lubrication (gudgeon and slippers). The oil feed is ad- ıble. The driving axleboxes are also d with forced feed lubrication.

ıe bogie and bissel truck are fitted ı S. K. F. roller bearings fixed on axles by means of conical rings in parts. This method of fixing facili- the examination and replacement ıe bearings.

ıe bogie frame plates are 30 mm. '16") thick. The guides for the roller bearing axleboxes are welded on to these frame plates.

The springs for the two axles are coupled together by means of equalizers.

The side movement of the bogie is 90 mm. (3 9/16") in each direction. The centring is controlled by means of laminated springs having an initial tension of 800 kgr. (1 760 lb.); this tension rises to 3 400 kgr. (7 500 lb.) at maximum side movement of the bogie.

The trailing bissel truck has a movement of 80 mm. (3 1/8") in each direction, and the centring of it is controlled by means of spiral springs.

The springs of the bissel truck are conjugated with the springs of the driving axles by means of longitudinal cranked equalizers; these latter axles are, in their turn, conjugated by means of standard equalizers.

Boiler. — The boiler (figs. 2 to 5), which has a firebox of the round top type, has no special features. Its working pressure is 18 kgr. per cm² (256 lb. per sq. in.); the heating and superheating surfaces are respectively 198 and 71.2 m² (2 131 and 764 sq. ft.). The grate area is 3.86 m² (47.3 sq. ft.).

The firebox backplate is very steeply sloped. The side plates are also sloped.

The boiler barrel is formed of two rings 1.620 m. (5' 3 25/32") in diameter. The tube nest comprises 30 large tubes 135 mm. (5 5/16") inside diameter, and 113 small tubes 50 mm. (2") inside diameter. The distance between the tubeplates in 6 m. (19' 8 1/4").

The boiler barrel and outer firebox are made of carbon steel having a tensile strength of 40-52 kgr./mm² (25.4 to 33 Engl. tons per sq. in.), and an elongation of 22 %. The flanged portions of the boiler are also made of carbon steel, but the tensile strength is only 33-42 kgr./mm² (21 to 26.7 Engl. tons per sq. in.), with an elongation of 26 %.

The inner firebox and the stays in the firebox sides are of copper.

The vertical crown stays are of steel.

The superheater header is made in one piece, with separate spaces for the saturated and superheated steam.

The superheater tubes have an outside diameter of 36 mm. (1 7/16"); the distance from the firebox tubeplate to the ends of the superheater tubes is 250 mm. (9 7/8").

The smokebox (fig. 5) contains a blast pipe fitted on the centre line of the chimney; two petticoats are provided over this blast pipe for ensuring as perfect a mixture as possible of the gases with the exhaust steam, the object of this being to reduce the pressure of this steam, in order to obtain a maximum vacuum in the smokebox.

A second locomotive of the same type is to be fitted with a double chimney and blast pipe, similar to those which have given such good results on a large number of locomotives on the French railways, and the comparison thus made possible between the results obtained on the two locomotives will enable the best arrangement to be adopted.

The empty weight of the locomotive is 86 t. (84.6 Engl. tons), and the weight in working order 94 t. (92.5 Engl. tons). The adhesive weight is 51.6 t. (50.8 Engl. tons). The tractive effort is 10 600 kgr. (23 370 lb.).

Tender. — The tender is carried on two bogies with wheels 1 m. (3' 3 3/8") in diameter. The distance between bogie centres is 3.800 m. (12' 5 5/8"), and the overall length is 5.700 m. (18' 8 7/16").

The water and coal carrying capacities are respectively 32 m³ (7 040 Br. gall.) and 9 tons. The empty weight and weight in working order of the tender are respectively 29 t. and 70 t. (28.5 and 68.9 Engl. tons).

The bogies are fitted with a double spring gear; the longitudinal springs are placed between the axleboxes and the bogie frame; transverse springs are also

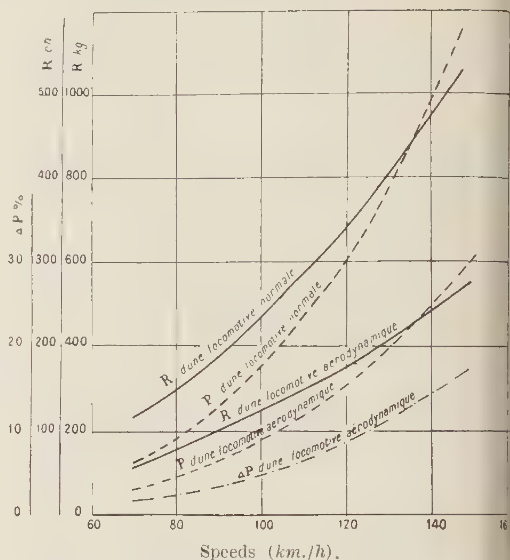


Fig. 6. — Graphic comparison of certain characteristics of an ordinary locomotive and a streamlined locomotive.

P, power necessary for overcoming the air resistance R (in kgr.).

P, percentage difference in favour of the streamlined locomotive.

Note. — R d'une locomotive normale (aérodynamique) = resistance of an ordinary (streamlined) locomotive.

provided between the bogie frame and the tender frame.

The bogie pivots rest on spherical centres which allow the bogies to move freely relatively to the tender frame, in spite of irregularities in the track.

Brakes. — Special arrangements have been adopted with a view to shortening the braking distance at high speeds. For this purpose, a device was adopted embodying the use of the compressed air at pressures varying with speed. Moreover, the pressure on the tender wheels varies according to the quantity of water in the tanks. The change in pressure is effected automatically when the speed is reduced to 50 km. (31 miles) per hour.

The pressures exerted by the brake blocks on the coupled wheels represent 130 % of the static pressures of the

wheels on the rails at speeds exceeding 50 km. per hour, and only 70 % below these speeds.

The pressures exerted by the brake blocks on the tender wheels also correspond to 130 % of the weight of the tender with the reserve of water in the tanks at speeds higher than 50 km. per hour, and 70 % at the lower speeds.

The pressures exerted by the brake blocks on the bogie wheels are invariable; they amount to 50 % of the static pressure on the leading wheels, and 70 % on the trailing wheels.

* * *

We do not intend to go beyond this general description of a locomotive which does not embody any unusual departures from the designs adopted in other countries on locomotives of similar types, but which has been the subject of very careful thought in every detail of its construction.

The « First Locomotive Works of Poland Ltd. » set out to build a locomotive embodying all the most up-to-date improvements in design from the point of view of streamlining and braking conditions. These improvements are of very great importance in view of the high speed [(140 km. = 87 miles) per hour] at which this locomotive is to run.

[621. 132.8 (.62)]

New Sentinel locomotives for the Egyptian State Railways.

Axle-hung geared steam engines, giving individual drive to two axles.

(*The Railway Gazette.*)

Four locomotives have recently been upplied to the Egyptian State Railways y the Sentinel Waggon Works (1936) Limited. Classified in accordance with lectric locomotive practice, they rank s the 1.A.A.1 type, each driving axle aving its own independent engine unit, nd the driving wheels not being coupld; apart from this last feature they ould, in steam locomotive notation be eferred to as 2-4-2 locomotives. Two f the locomotives are arranged for coal ring, and two for burning oil. The esential feature of the design is the use f totally enclosed force-lubricated enne units, geared to and suspended om the driving axles, in place of the onventional cylinders and coupling nd connecting rods of the ordinary loomotive.

There are two engine units, each with cylinders 11 in. diam. by 12 in. stroke, mounted on the driving axles in a similar manner to axle-hung electric motors, and suspended from the main frames at the cylinder end by a transverse beam supported on rubber springs to take the axle torque and absorb any shocks transmitted from the rail. The arrangement provides a three-point suspension, so that unequal movement of the axleboxes in the guides when on uneven track cannot throw any stresses upon the engine or suspension system. To compensate for the movement of the axleboxes in the guides, flexible joints of Sentinel design and manufacture are provided in the steam and exhaust pipe system. The joint, which consists of a ground spherical end housed in a spherically seated flanged connection, is shown in one of the accompanying

drawings. Steam pressure in the pipe line forces the ball end more firmly on its seat and assists in maintaining tightness. Many of these flexible joints have been supplied for use on locomotives and railcars in all parts of the world during the last twelve years, and they have always proved trouble-free in service.

In order to compensate fully for possible movement in all planes, three joints of this type are fitted in each steam and exhaust pipe line. The mounting of the engines on the axle makes it possible to arrange the bearings outside the wheels, where they are accessible for greasing and maintenance. Each driving axle is independently driven so that coupling rods are not required. These wheels, fitted with Timken roller bearings, are the same diameter as those of the tender, so that the same tyres can be used for both. The main crankshaft bearings for the engine unit are of the SKF double-row self-aligning roller pattern. The boiler is a duplicate of that of the 4-4-0 type passenger locomotives recently constructed by the North British Locomotive Co. Ltd., for the Egyptian State Railways. The working pressure, however, is increased to 200 lb. per sq. in. As far as possible, all boiler mountings and other details are duplicates of the corresponding items on the 4-4-0 type locomotives.

The engine units.

The engine units are designed throughout to give reliable trouble-free service over very long periods with sustained low steam consumption and with the minimum amount of attention. Compared with the conventional, directly-connected locomotive, the bearing pressures are much lower, being, for example, only 770 lb. per sq. in. of projected area for the main crankpins, whilst the main crankshaft bearings are of the roller type and very conservatively rated. The gears are mounted on the centre of the axle and engine unit, thus giving equal loading to the engine support bearings on the axle, which are of very generous proportions so that even under the worst possible combination of conditions at starting, the loading does not exceed 105 lb. per sq. in. of projected area.

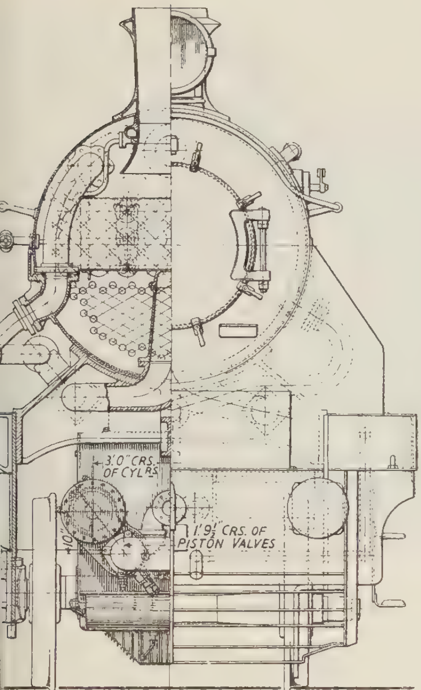
The valve gear, of modified Hackworth type, is also most generously proportioned throughout, and driven by a separate crankshaft, gear-operated from the main shaft, so that there are no large eccentrics with attendant high rubbing velocity and risk of overheating.

A well-designed system of forced lubrication is provided, with pressure feeds to crankpin and crosshead bearings, valve gear, crankshaft and crankpin bearings, valve spindles, crosshead pins, etc. The main gears, and also the die blocks of the valve gear operate in an oil bath. In consequence of the low bearing pressures, adequate lubrication, and entire exclusion of dust and foreign matter by reason of the total enclosure of the engine units, the wear on the moving parts cannot be more than infinitesimal, and very substantial economies in maintenance and repair costs as compared with the conventional locomotive are thereby expected. This is especially important in view of the extremely dusty conditions prevalent upon some sections of the Egyptian State Railways.

Advantages of the Sentinel type locomotive.

For the Sentinel type of locomotive, it is claimed that appreciable economy in fuel and water consumption is assured, for the following reasons :

Reduced steam consumption : Due to greater accuracy of small cylinders machined to precision limits, and reduced losses on account of higher engine revolution speed at any given piston speed



front view and section through smoke- of new Sentinel geared locomotive, ptian State Railways.

eam velocity. On actual tests, con- ions of 14-16 1/2 lb. per B.H.P. obtained over a wide range of s and cut-offs with steam temper- of 600° F.

uced fuel consumption : Due to steam demand and to the more able blast conditions occasioned almost continuous exhaust of the engines.

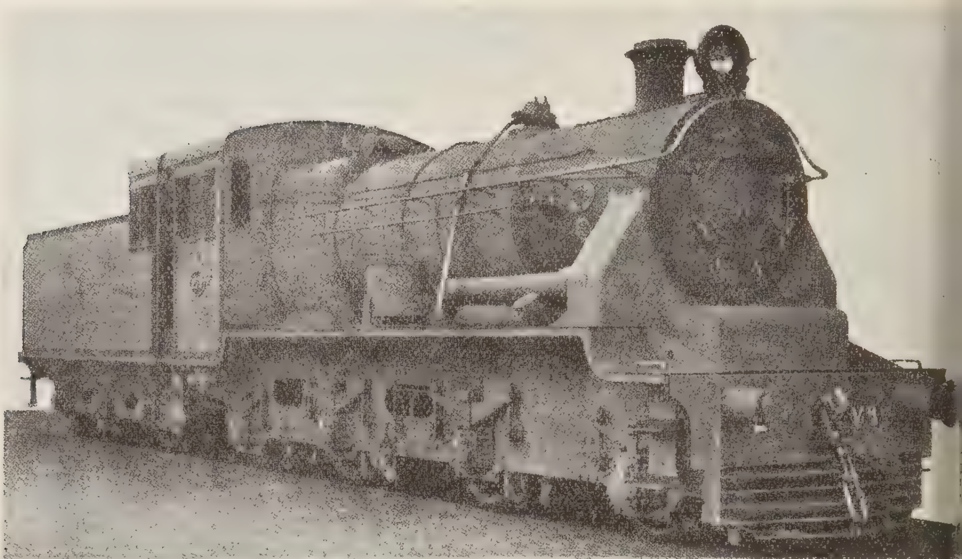
nomy in maintenance costs : A economy in maintenance costs is d by reason of the adoption of the ed engine unit in conjunction with lubrication as compared with the rive of the directly connected en- This is a most important feature, especially under the unfavourable conditions encountered on many sections of the Egyptian State Railway system.

Improved blast conditions : At the nominal full speed of 51.5 m.p.h., the engine units are running at 600 r.p.m., which with two engine units operating out of phase, gives 4 800 blast impulses per minute. A conventional locomotive with 5-ft. 6 3/4-in. wheels is making only 265 r.p.m. at a corresponding speed, or only 1 024 blast impulses in the same period. The effect of the more frequent and less intensive blast of the geared locomotive is to maintain a more continuous and even vacuum in the smokebox with resultant improved combustion efficiency and reduced tubeplate maintenance, thus contributing to economy in both fuel and repair costs.

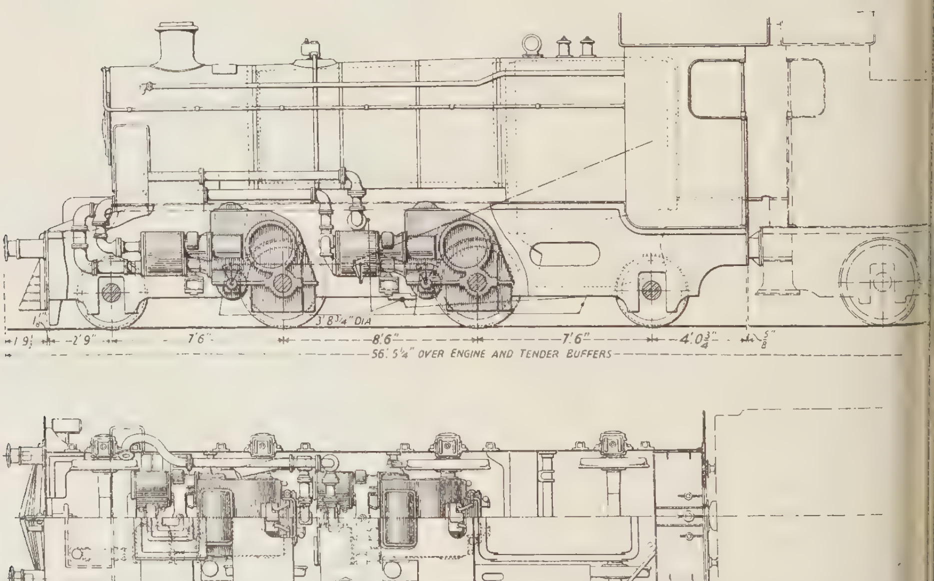
Elimination of hammer blow and steadier running : As there are no connecting and coupling rods, and as the engine units are internally balanced, there is no necessity for balance weights in the wheels, and hammer blow on the track is practically eliminated. As a result the locomotives might be permitted to operate on lines normally restricted to engines with a lower maximum axle load. The absence of piston thrust and slidebar reactions, too, tends to steady riding at the highest speed obtainable.

Under favourable conditions, up to 40 % economy in fuel consumption can be obtained with geared as compared with ordinary locomotives on shunting and similar duties. In passenger service, such as the new Egyptian locomotives are designed for, there should also be appreciable, though not of course quite such substantial, economy, and this in conjunction with the other advantages enumerated.

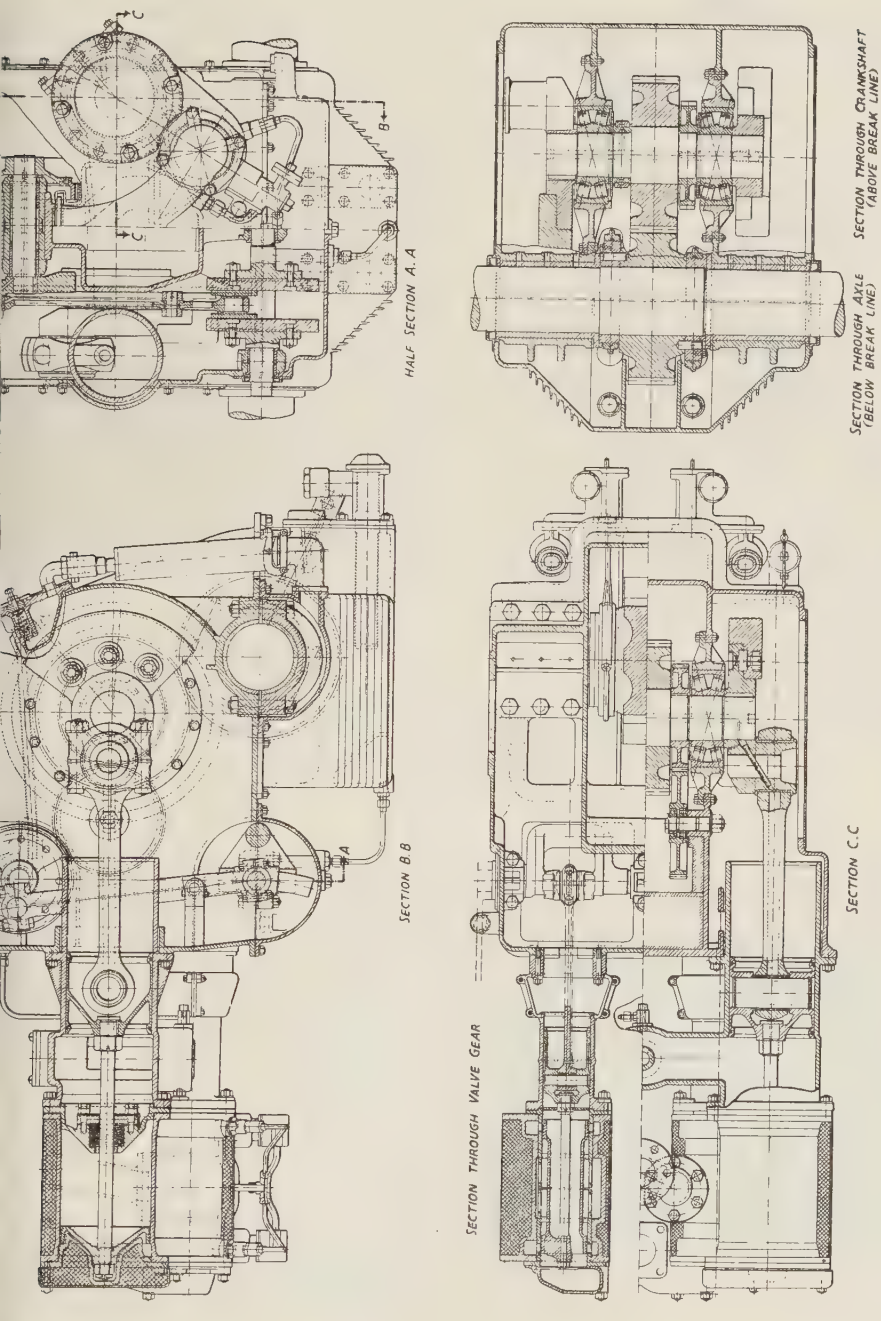
A particularly interesting feature of the introduction of this class of locomotive is the opportunity of direct comparison with new locomotives of the most up-to-date conventional type con-



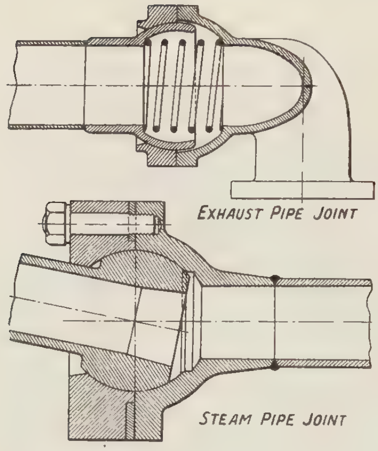
View of new Sentinel locomotive.



Diagrams showing arrangement in elevation and plan of engines on geared Sentinel locomotive.



Sections through totally-enclosed engine and geared transmission of Sentinel locomotive, Egyptian State Railways.



Flexible joints in steam and exhaust pipe system.

structed at the same time, and as far as the boiler and running gear are concerned, in the same work. The relative performances of the four Sentinel-engined locomotives and the equivalent 4-4-0 type locomotives with Caprotti valve gear built by the North British Locomotive Co. Ltd. and described in *The Railway Gazette* of December 10, 1937, will furnish valuable data.

The locomotives were designed by the Sentinel Waggon Works (1936) Limited, in conjunction with the North British Locomotive Co. Ltd., of Glasgow. The engine units themselves, together with flexible pipe joints, etc., were built at the Sentinel Works at Shrewsbury. The traction gears were supplied by Alfred Wiseman & Company, of Birmingham; and the boiler, frames, tenders, etc., by the North British Locomotive Co. Ltd., at whose works the erection was completed.

The general characteristics of the locomotive are shown in the accompanying drawings.

[656. 254]

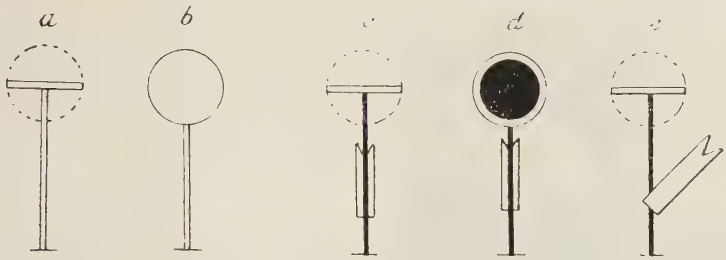
The « Parisienne-Metrum » (P. A. M.) cab-signalling system.

(*Le Génie Civil.*)

Cab-signalling i. e. repeating the aspects of running signals inside the cab of locomotives has been used in France for more than fifty years, generally by means of fixed contacts (so-called « crocodiles ») mounted between the rails. More recently, and particularly since the War, other countries have tried out or adopted cab-signalling apparatus for their railways, based on other principles : thus inductive train control systems are now used particularly in America, Switzerland and Germany; in addition, in England and Italy various non-electrical systems have been tried out, or if already adopted, their use has been extended.

Engineers have paid particular attention to the inductive types of train control systems, and it is interesting to note that in the United States only one case of failure was noted during the course of 29 690 108 consecutive operations or in other words, the rate of failures is one in thirty millions.

In Europe, the Swiss Federal Railways have carried out since 1936 a programme for equipping 3 000 km. (1 860 miles) of track and 374 electric locomotives with the « Metrum » type of inductive train control, and following the excellent results obtained therewith (20 000 000 km. = 12 400 000 miles covered by the 374 locomotives without



Line clear. Caution. Line clear. Caution. Reduce speed.

Fig. 1. Fig. 2.

Figs. 1 and 2. Diagrammatic aspects of running signals.

failure affecting the safety of the fic), they decided to so equip the ole of their system by the end of 7. This particular equipment at pre-t only repeats the « stop » indica-1, but may be modified to give three nal indications, which the equipment some Swiss locomotives is already e to do.

n France, where this problem is at sent being closely investigated, trials e been carried out with different sy-ns, amongst them the Metrum type, we give below a description of the allation submitted to the French lways by the Parisienne-Metrum A. M.) Company.

ndications required. — Certain rail- signalling experts have considered esirable to enlarge the scope of the em beyond that covered by the type present used in Switzerland, which ever includes the automatic applica- of the brakes. They have therefore idered it necessary, at least to co- immediate requirements, to call for tition of the following indications :

Stop »;
Reduce speed »;
Line clear ».

e programme of the trials of the . M. apparatus therefore covered e signal aspects, all of which had to ndicated on the locomotives of both express and freight trains. The signals concerned had mechanical operation and had either (fig. 1) *two aspects : (a)* « line clear » and *(b)* « caution », or (fig. 2) *three aspects (c)* « line clear », *(d)* « Caution », and *(e)* « Reduce speed ».

It should be noted that the trial installations repeated these different aspects in the locomotive cabs and recorded them by means of the apparatus already mounted in them.

The P. A. M. system is *a non-resonating system* and requires, therefore, only a simple type of equipment.

Description of the « Parisienne-Metrum » system. — In addition to the recording apparatus of standard design the P. A. M. system comprises on the lo-

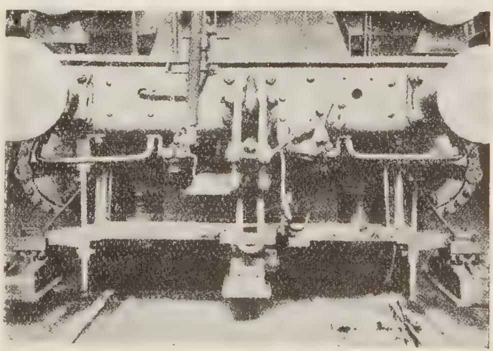


Fig. 3. — Mounting of the three electro-magnets on the locomotive.

Fig. 4. — The three fixed electro-magnets installed in the track.

comotive (fig. 3) three electro-magnets as follows :

a transmitting electromagnet mounted on the axis of the locomotive; this magnet is permanently energised by 24-volt d.c. supplied from the turbo-generator set already mounted on the locomotive for the lighting current supply, which need not be changed;

two receiving electromagnets, mounted on each side of the locomotive.

In addition, a case is provided in which are mounted the relays and fuses required for the circuits of the recording and repeating apparatus inside the cab.

The track equipment (fig. 4) also consists of three electro-magnets as follows:

One electromagnet mounted in the axis of the track (between the rails);

Two electromagnets, one mounted outside each rail.

In addition a commutator mounted on the signal, governed by the aspect of the latter and connected to the track electromagnets, is also required.

Of course, the electromagnets on the locomotive (the wiring of which is shown on fig. 5) and the track electromagnets are mounted to « correspond » in the vertical plane.

No current supply is required on the track. — Figure 6 shows a diagram of the track equipment required for a three-indication system.

Together with figure 5, figure 6 clearly shows the simplicity of the system, which uses the following combinations to indicate three different signal aspects:

For « line clear » : magnet v_0 feeds v_1 and v_2 in parallel;

For « caution » : magnet v_0 feeds only v_1;

For « reduce speed » : magnet v_0 feeds only v_2.

The installation is completed by the following apparatus mounted inside the cab for the locomotive driver's attention :

An audible warning signal (hooter);

An optical (lamp) indicator which repeats the signal aspects on a screen;

A violet lamp for the detection of the current supply;

A so-called « vigilance » button (mounted on the recording apparatus) which makes it possible to ascertain whether the driver has seen the signal he passed, in due time or too late.

No action on the part of the driver is necessary when the signals are at « line clear », and *any premature action on his part* does not affect the correct operation

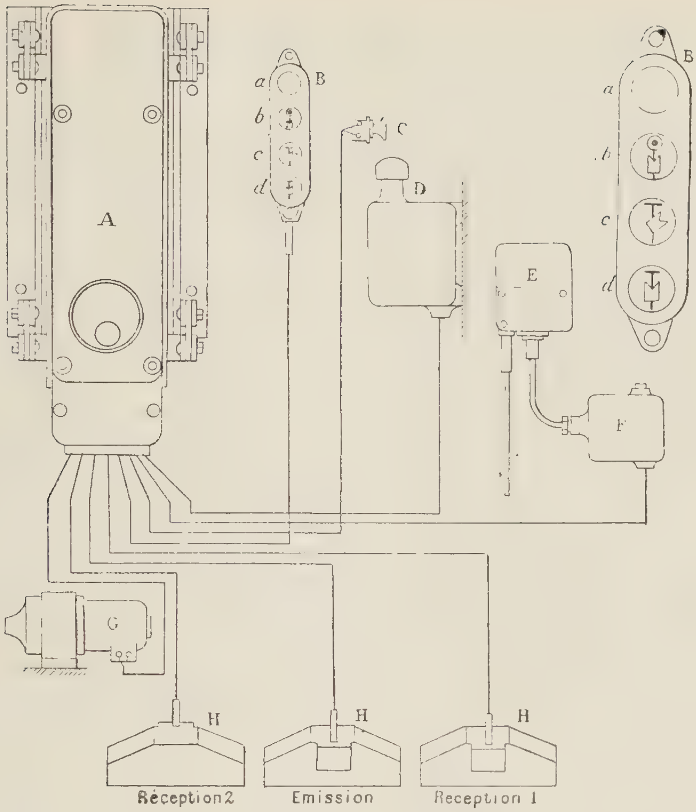


Fig. 5. — Wiring diagram of the equipment on the locomotive.

Legend:

·paratus case. — B, optical repeater (*a*, detection; *b*, caution; *c*, reduce speed; *d*, line clear). — audible warming signal. — D, acknowledging button. — E, recording apparatus. — F, terminal x. — G, 24-volt turbo-generator set. — H, electromagnets (1 for transmission, 2 for reception).

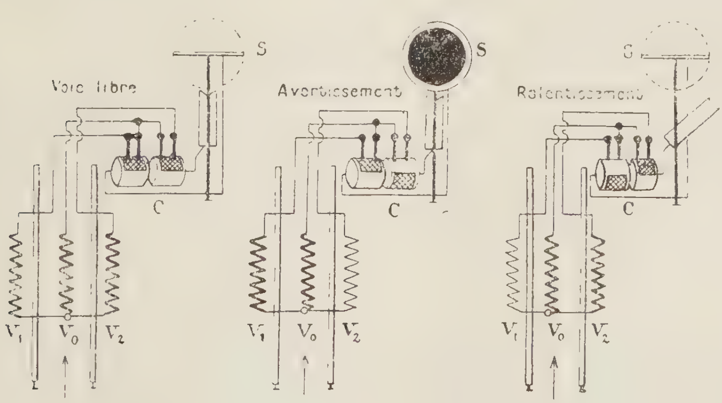


Fig. 6. — Diagram of the equipment for a running signal.

C, commutator of signal S. — V_0, V_1, V_2, track magnets.
The arrow indicates the running direction.

ote. — Voie libre = line clear. — Avertissement = caution. — Ralentissement = reduce speed.

of the apparatus. It should be noted that if no action is taken in either of the two other cases, the apparatus will continue to display the aspect of the signal that has been passed, unless the next signal displays a still more restrictive aspect.

Operation of the system. — When the driver passes a signal at « line clear », the signal aspect is repeated inside his cab and the audible indicator is heard for a short period; without any action on the part of the driver all the apparatus goes automatically back to *normal.* The transmission of the « line clear » aspect therefore does not inconvenience the driver in any way; he merely receives a subdued warning of such indication and the passing is recorded whether he takes any action or not.

However, when the train passes a signal showing any other aspect than « line clear », then the action of the hooter, the recording on the registering device and the representation of the signal aspect inside the cab will continue until the driver has pressed the « vigilance » button; such acknowledgment is then duly recorded and the whole apparatus returns back to its *normal* position.

In other words, normal running entails *no additional duty* on the part of the driver but when the section of track ahead is occupied, thus calling for action on his part, his vigilance is checked and recorded.

The running of the train is permanently detected by means of a graph on a continuous paper band on which the signal aspects and any acknowledgments of the driver are recorded (fig. 7). These paper bands are inspected by the officers in charge of the traffic control.

With regard to the actual operation of the apparatus, it should be remembered that the transmitting electromagnet on the locomotive, when passing over the electromagnet mounted in the centre of the track, causes an inductive current to flow to the two magnets mounted on the sides of the rails, and these magnets in turn energize one or both of the lateral magnets on the locomotive, the selection being made by the signal commutator. It is thus possible for the inductive current to flow to the receiving relay or relays as shown by figure 8.

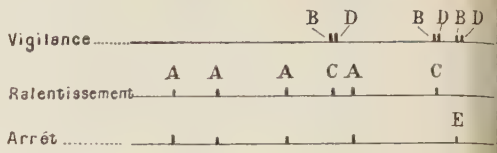


Fig. 7. — Extract from a record band.

A. Line clear. — B. Acknowledgement. — C. Reduce speed. — D. Resetting. — E. Stop.

Note. — Arrêt = stop.

Following this general description we shall now examine particular features of the operation of the apparatus in detail.

The transmitting electromagnet on the engine, fed with 24-volt direct current, continuously radiates a magnetic field of constant strength. When passing over the central track magnet it will therefore induce in the winding of this magnet an alternating current wave, the frequency of which will vary with the running speed.

The circuits formed by the connection of the centre track magnet with *one or the other or both the outside track magnets* are thus fed with an alternating current in the same way as a transformer primary winding. On account of the relative motion of one or both outside track magnets, which become transmitting magnets to the one or the other or both corresponding receiving magnets on the locomotive, the current induced by one or both track magnets in one or both outside locomotive magnets has double the frequency of their own.

The oscillographs recorded by the

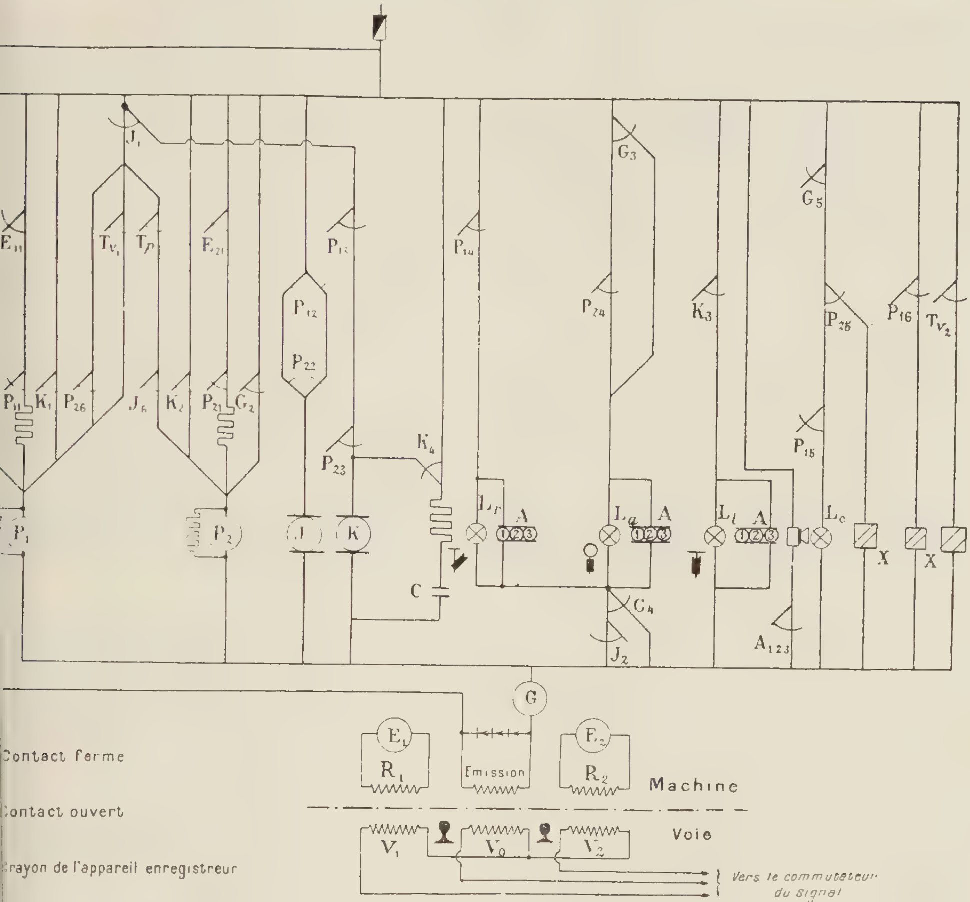


Fig. 8. — Principle of design of 3-indication cab signalling.

hree-winding relay. — C, condenser. — E_1, E_2, receiving relays. — G, guard relay. — J, auxiliary time lag relay. — K, auxiliary relays. — *Lc*, detection lamp. — L_1, line clear lamp. — *La*, caution lamp. — *Lr*, reduce speed lamp. — P_1, P_2, main relays. — R_1, R_2, receiving magnets. — *Tr*, acknowledging button. — V_0, V_1, V_2, track magnets. — X, pens of the recorder.

contacts relating to any given part are indicated by the reference letter of such part together with a numerical index. Thus the contacts relating to P_1 are indicated by P_{11}, P_{12}, etc.; those relating to P_2 by P_{21}, P_{22}, etc.

e. — Contact fermé = contact made. — Contact ouvert = contact broken. — Crayon de l'appareil enregistreur = pen of the recorder. — Emission = transmission. — Machine = locomotive. — Voie — track. Vers le commutateur du signal = to the signal commutator.

ss Federal Railways (fig. 9) give in- hation on the amplitude of the wave on the characteristics of the cur- s induced in the receiving circuit; frequency and the resulting ampli- s corresponding to the different trial speeds are clearly shown. The *outside locomotive electromagnets* thus form the secondary winding of the aforementioned transformer, a particular feature being that this secondary being in motion relatively to the primary, has

a relative speed equal to that of the transmitting magnet with regard to the track centre magnet.

The results shown by figure 10, which have also been recorded on the Swiss Railways, indicate that the amplitude varies as the speed of the train.

Il will be noted that with the present type of apparatus, and for speeds exceeding approximately 30 km. (19 miles) an hour, its value will remain fairly constant; below this speed, the value of the wave strength drops rapidly and at approximately 3 km. (1.9 miles) an hour, becomes too small (unless the clearance is reduced) to operate the receiving relays.

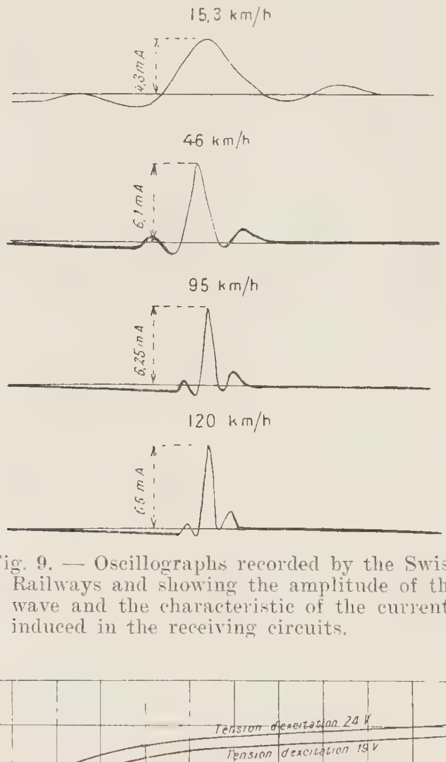


Fig. 9. — Oscillographs recorded by the Swiss Railways and showing the amplitude of the wave and the characteristic of the currents induced in the receiving circuits.

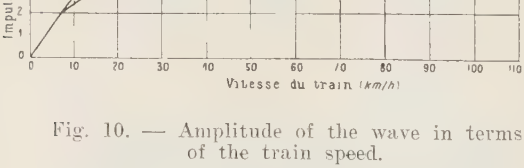


Fig. 10. — Amplitude of the wave in terms of the train speed.

Impulsion du courant = current strength. — Tension d'excitation = energizing voltage. — Entrefer de 100 mm. = clearance of 100 mm. (4"). — Vitesse du train = train speed.

The present French trials have already been carried out for eighteen months; the installations have therefore experienced every season of the year. Not a single failure endangering safety has been recorded during that time; it was found that the system was reliable under all weather conditions, and that its maintenance was both simple and economical. This proves that, as it is not affected by atmospheric conditions, and as only a simple apparatus is required, no particular precautions are called for.

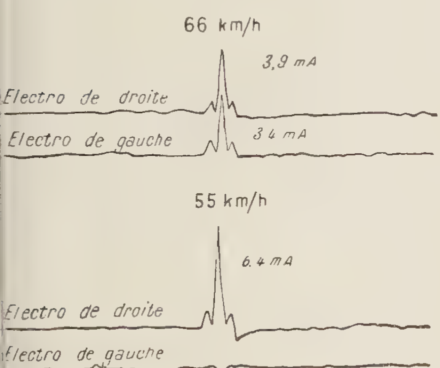
Conclusion. — We will now summarise the facts which explain the success of the French (P. A. M.) system, which had already led the Swiss Federal Railways to generally adopt the simpler system originally created by the Metrum Company.

(a) It should first be noted that every passing of a signal at « line clear » calls for the operation of all electromagnets (three on the track, three on the locomotive) and all relays of the installation; any complete or partial failure of any one of the parts concerned would therefore make it impossible for a « line clear » aspect to be repeated and would lead to the indication of a more restrictive signal aspect inside the cab. Seeing that, as a matter of fact, the trains generally meet the signals at « line clear », this gives *a continuous control of all parts of the equipment both on the locomotive and on the track, which have to operate in order to give the signal repetition.* Therefore no special inspection trip, no special vehicle, no laboratory with a specialised staff

·e required to verify the correct oper-ion of the equipment; *it is the locomo-ve itself which carries out such routine spection automatically* and without ɪpense, which is, of course, a great ad-ıntage.

(b) Not only is this arrangement al-·ady highly satisfactory in itself, but it ıs also made it possible to use appa-tus which guarantee correct operation. his correct operation is ensured by ing relays of a simple type, not oper-ed under high frequencies, and there-re highly efficient and fully reliable.

(c) The current of the track centre ectromagnet being split up in two, the nplitude of the currents of the receiv-g circuits is reduced in consequence. gure 11 shows this amplitude exactly scale : its mean value is 3.5 milli-nperes for a signal passed at « line ear » at a speed of 66 km. (41 miles) ı hour, whereas it rises to 6.4 milli-nperes for a signal passed at danger, a speed of 55 km. (34.2 miles) an ›ur.



ɡ. 11. — Amplitude of the wave in the ·eceiving circuits when passing a signal.

ı. · Electro de droite = right-hand magnet. — Electro de gauche = left-hand magnet.

Nevertheless, figure 12 shows that the ıplitude is far from negligible at very v speeds. It will be noted that for a ›ed of 5 km. (3.1 miles) an hour, with

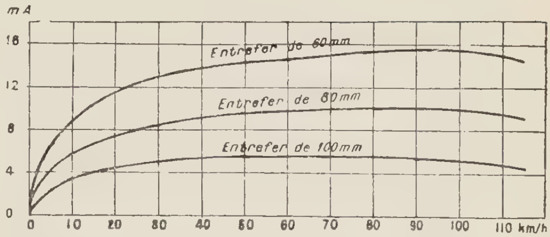


Fig. 12. — Amplitude of the wave in terms of the train speed for different clearance values.

both outside track electromagnets energized (e. g. in the case of « line clear ») the amplitude never drops below 1 milliampere, even if the clearance is as much as 100 mm. (3 15/16") and even 130 mm. (5 1/8") as shown by certain tests recently carried out in Switzerland). It is only necessary for such small amplitudes still to energize the relays; experience has shown that whilst free from undesired applications, they have in this respect such a margin of safety that it is not necessary to use amplifiers.

It follows from these observations, and our statement is backed by many years' experience, that with the apparatus at present in use, « line clear » aspects are definitely recorded for all speeds above 4 to 5 km. (2.5 to 3.1 miles) an hour; as mentioned previously « stop » indications are recorded for a speed of approximately 3 km. (1.9 miles) an hour and upwards.

(d) The clearance between the electromagnets on the locomotive and those on the track has been fixed in principle at 80 mm. (3 1/8"); the results in service have shown that the operation is not affected by the variations in clearance encountered in actual running conditions, even if the voltage should drop from 24 to 19 volts.

(e) Whereas certain systems do not give any indication when running in reverse direction, inversion of the indica-

tions is easily obtained in this case by simply operating the reverser of the standard recording apparatus inside the cab.

(f) No special operation is required to start the installation; the locomotive turbo-generator set (fed from the same steam supply as the brake pump) being used for the current supply, the installation is automatically started together with it. *As no action of the driver is called for, on oversight on his part is impossible.*

(g) As only a low-tension current is used there are no particular difficulties in insulating the circuits. It is only necessary for the voltage to remain at 24 volts within limits of $\pm$ 3 volts to ensure correct operation, even if the steam pressure should vary between 8 and 18 kgr./cm^2 (114 and 256 lb. per sq. in.).

(h) As there is no current supply on the track, maintenance of the track installations is reduced to a minimum.

(i) In addition to the continuously repeated detection of the complete installation, a violet detection lamp, mounted at the start of the transmission circuit, definitely detects any failure in the general current supply.

To sum up, after 18 months of tests covering a much more extensive programme than it was called upon to fulfil outside France, the P. A. M. system offers a satisfactory solution of the cab-signalling problem. Additional tests have shown, moreover, that with this system it is possible to solve certain associated problems, such as arise in the case of an accidental obstruction of the running lines, or in order to protect men working on the track, a special track electromagnet for rapid mounting on the rails, as shown in figure 13, is used for such cases.

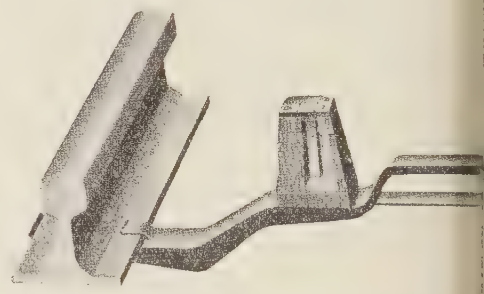


Fig. 13. — Special track magnet for rapid mounting on the rails for transmitting orders to running trains.

Finally, the P. A. M. system can easily be adapted to fulfil any supplementary requirements in addition to the number of indications originally called for; all that is necessary is to complete the original installation by a number of additional elements *without any expensive or difficult replacements being necessary.*

The use of luminescent tubes to supplement signals in tunnels,

by ROBERT LÉVI,

Chief Civil Engineer, French National Railways Company (Western Area).

(Revue Générale des Chemins de fer.)

visibility of signals situated in ls, on non-electrified lines, invol- wo distinct problems : one con- the range of the signals through bscurity of the tunnel, and the the true identification of the col- lisplayed. These problems are par- rly acute in tunnels which, during n hours of the day, are filled with smoke.

h is the case in each direction at ı RD (Right Bank) Station, since ıtroduction of the new methods of ling on the French railway sys-

square type of signals admitting station are now grouped, and the signals, in the form of illuminated , calling for a speed reduction, laced a short distance from the witches of the station, and these ıes, over which numerous move- take place, are inside the long s which begin roughly 50 m. (165 yond the station ends.

The range of signals situated in tunnels.

would suppose the distance at a signal light might be seen could easily be increased by raising the g power. This is not so, for the ng reason.

ıgine a lamp with a perfect optical designed to project a pencil of l beams. The amount of illumin- eceived on a screen placed in front h a lamp, instead of remaining ıt and independent of the distance ıld be the case in pure air (for a of parallel beams) is partly absorbed by each successive layer of smoke-laden atmosphere through which the light beams pass, and the amount of light remaining diminishes in a geometrical progression, or rather, in accordance with an exponential law.

The weakening of the light may, for example, be in the proportion of 100 to 1 in a distance of one metre that is, of such a degree that in order to increase the range by one metre, the power of the light source would have to be increased a hundredfold.

The illumination received on a screen is a measure of the impression produced on the retina and it may therefore be said, that for a comparatively feeble light, the distance from which a signal becomes visible to the enginemen through a pall of smoke, is a quantity which, if small in itself, is also little influenced by the intensity of the source.

It is desirable the enginemen should be able to see the signals for an appreciable time, particularly in the case of the yellow light of the warning signal. On the other hand, the duration of visibility is equally important in the case of those signals, the « stop » aspect of which has been indicated by the aspect of the preceding signals, for, when a driver finds an approach signal at « stop » at the entrance to a tunnel, he can proceed only at a very reduced speed, without any certainty of where he will find the stop signal or what its aspect will be when he encounters it, and it is desirable to reduce this uncertainty.

The solution adopted in the tunnel just before entering Rouen (R. D.) Station consists in providing, in addition to the

signal panel comprising green, yellow and red lights, respectively three luminescent tubes, green, yellow and red, five metres (16' 5") long, and which are lit up in accordance with the indications of the panel.

Each of these tubes, when energised, produces an irradiation of the surrounding smoke, which can be seen at least several metres ahead, so that under the very worst conditions the driver sees a coloured glow over a distance of some ten metres (33').

Even at maximum speed, this is visible long enough for a driver on the look-out for the signal to be certain of the colour, whereas without the irradiation of the smoke by the tubes, the colour would only be visible for a third or quarter of the time.

2. *Colour values of the lights.*

For visual signals in tunnels to be interpreted without ambiguity by a driver, it is important that their colour values should be unmistakable — by which we mean, incapable of being confused with any other colour used for signalling purposes — whether the smoke density be slight or considerable.

The light absorption phenonema occurring, particularly in tunnels, vary according to the size of the smoke particles, and are more marked for the shorter wave-lengths than for the longer ones, with the result that a beam of light which is not absolutely monochromatic has its spectral composition more or less modified, according to circumstances, always tending to become increasingly red.

It will be understood, therefore, how, under the influence of smoke, green signals tend to show up as white or yellowish white, and yellow signals tend to turn red.

If luminescent tubes are used, however, it is possible to ensure that the light emitted is monochromatic, or nearly so, and under these conditions the absorption by the smoke no longer changes the col of the light; also it reduces its brillian

This principle has been applied by State Railways in experiments, c ducted over a number of years, in Beauvoisine tunnel, at the approach Rouen (R. D.) Station. They were c cerned solely with green light.

In the new application now describ the light given out by each of the th luminescent tubes has been made as m nochromatic as possible.

The red colour is produced by mea of a neon tube from which, however, orange rays are filtered by the glass.

For yellow, a tube containing a m ture of argon and neon is used and red rays are filtered out by the contain The radiation emitted has a wave-len of very nearly 5 780 angströms, that to say it is situated, not in the oran yellow range of the spectrum, but in pure yellow.

The impression received is a little d ferent from that of an ordinary yell light, but, as stated above, in this fo it is not liable to fading and cannot ca confusion.

For the green-coloured indication tube of uranium glass, illuminated means of mercury vapour and argon, been used. The light given out is chi ly concentrated in the neighbourhood the 5 480 wave-length, with a little yell light of wave-length 5 780. The light more obviously green than that of ordinary green lamp, and with a sli tendency towards yellow.

In figure 1 the spectra of the th luminiscent tubes are reproduced compared with the spectrum emitted an uncoloured lamp (lower line) with the spectrum of a mercury vap lamp (which appears three times in photograph).

These photographs illustrate in a q litative way the nature of the radiati emitted, but afford no opportunity judging their relative intensities.

In order to give some indication of

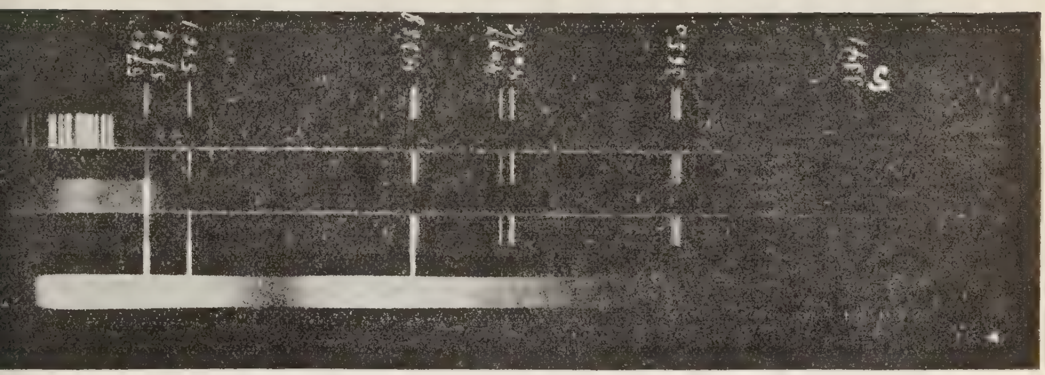


Fig. 1. — Comparison between the spectra of mercury vapour luminescent tubes and an uncoloured light.

. — Hg. = mercury. — Tube rouge = red tube. — Tube jaune = yellow tube. — Tube vert = green tube. — Lampe inc. = uncoloured lamp.

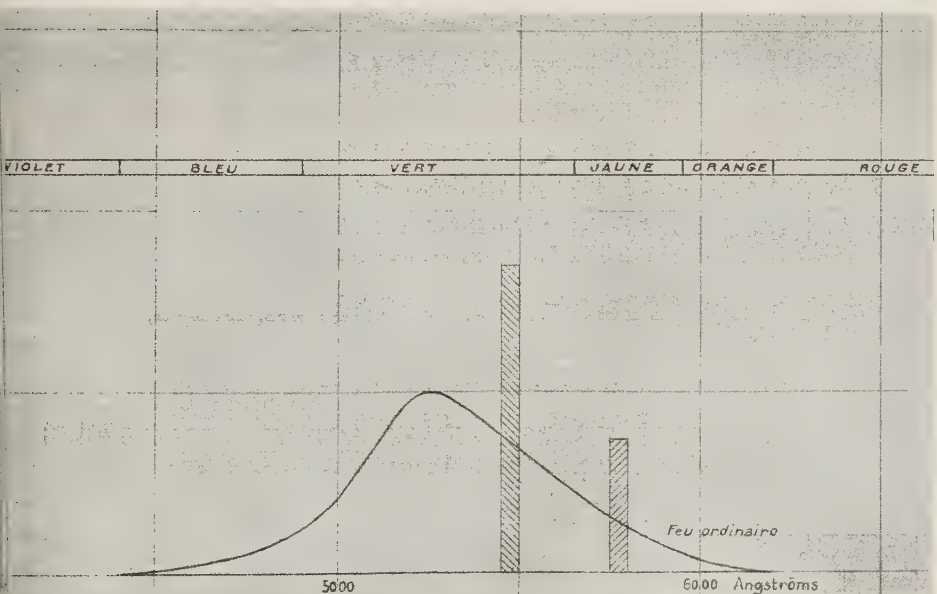


Fig. 2. — Visual impression — Green light.

Note. — Feu ordinaire = ordinary light.

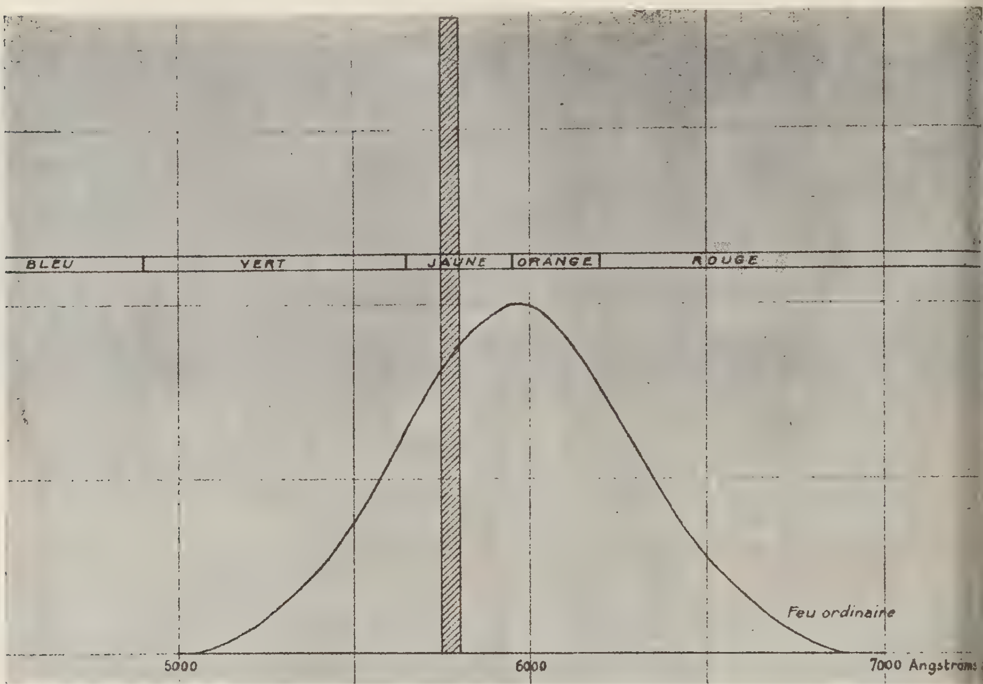


Fig. 3. — Visual impression — Yellow light.

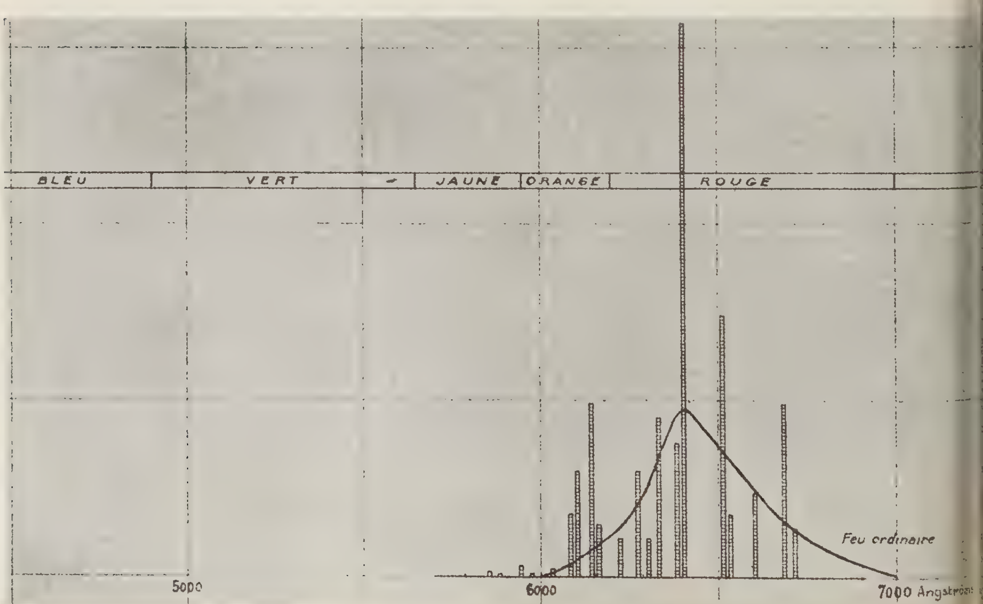


Fig. 4. — Visual impression — Red light.

ression of brightness produced, three rams, figs. 2, 3 and 4, have been pre- d, showing :

) by a curve — the intensity of the ations emitted by a conventional op- system, the intensities having been iplied by a coefficient correspond- with the sensitivity of the retina.

) by a « stepped » line — the va- s bands emitted by the luminescent s, still multiplying the intensities by same coefficient.

the diagram for red light (fig. 4) it be noticed that the usual types of produce their chief effect on the by means of wave-lengths in the hbourhood of 6 400 angströms, and the luminescent tube operates prin- lly on the same wave-length.

3. *The installation.*

he « panel » signals admitting to en (R. D.) Station, from both ends, prise lighting units placed at invert . Ahead are the luminous « mirli- » (striped posts) marking the ap- ch to each signal panel, and placed, at 250 m. (820') and the other at m. (490') therefrom. Each white e composing the « mirliton » is pro- d by means of a ground-glass dihe- illuminated from within.

The luminescent tubes are fixed at about 15 m. (50') ahead of the signal. Each consists of two elements 2.50 m. (8') long placed horizontally and in line with one another, and they are fed from a 115/3 000-volts 50-cycle transformer installed in an alcove in the tunnel. The three tubes are placed one above the other, in the same order as the principal lights of the signal panel, and repeat, according to the case, the « stop », « caution », « reduce speed » or « line clear » indications.

The results obtained during the last six months having been very satisfactory, it is now proposed to provide a similar installation for the down track from Trouville, at the portal of the Grand-Jardin Tunnel immediately preceding Lisieux station.

As a matter of fact, the use of luminescent tubes can be extended to cover the case of a stop signal not actually within a tunnel, but only a short distance outside it. The trouble experienced by drivers, although less marked, is of the same order, since in the first place they find it difficult to recognise the precise point at which to come to a stand, and in the second place the smoke cloud expelled from the tunnel by the train makes recognition of the signal almost as difficult as if it were within.

[62. (01 & 625.143]

Fourth Rail Congress,

held at Düsseldorf in 1938.

The Opening Meeting of the Fourth Rail Congress took place at Düsseldorf on the 19th September 1938, in the presence of Dr. J. DORPMÜLLER, the German Minister of Transport.

This Session was organised by the Reichsbahn and the Association of German Metallurgists.

Dr. P. Goerens, of Essen, the President of the Congress, stressed in his opening speech the fact that about 500 delegates were present, including amongst others, representatives of 20 European and American nations. This shows the ever growing importance of the Rail Congress since its first Sessions at Zurich in 1929 and 1932, and at Budapest in 1935.

In welcoming the delegates, Dr. DORPMÜLLER insisted on the predominant part played by the railways for more than a century in the commercial relations between States.

The railway will always be the method of locomotion with a low tractive resistance and its principal characteristics are fast and safe operation.

In Germany the railways deal with 81 % of the goods traffic and 91 % of the passenger traffic.

To be in a position to deal with such an amount of traffic under present conditions of speed and loads, the permanent way must be beyond criticism.

The use of such high speeds, the endeavour to give the passengers the maximum comfort, and the ever-increasing wheel loads mean new problems for the permanent way engineers, which leads to the need for collaboration and exchanges of opinion between railway engineers, welding engineers, manufacturers, and metallurgists of all countries.

Two general reports were read, on by Dr. Karl REMY, President of the Co logne Area of the Reichsbahn, on th economic character of rail transport the other by Dr. E. H. SCHULZ, of Dort mund, on the problem of the rail fro the metallurgical point of view.

A brief summary of the main ideas de veloped in these two reports is give below.

The agenda then included reports an discussions under the presidency of Dr M. Ros, on the subject of the loads an stresses developed in the track, pheno nema of wear, trials and inspection tes for rails, and finally the use of weldin in connection with the permanent wa

The delegates were invited to visit th Düsseldorf Steel Research Institute, an some rolling mills and track laying site in the Ruhr Valley.

* * *

The economic character of rail transport,

by Dr.-Ing. Karl REMY, President of th Cologne Area of the German Reichsbah

In his report Dr. REMY reviews th fundamental characteristics of the ra way, viz. :

(1) the possibility of running at hi speeds and maintaining the schedule and when needed, with at the same ti practically complete safety;

(2) ever-increasing comfort in t case of passenger services;

(3) the possibility, a fundamental a vantage, of transporting passengers a goods in bulk;

4) the great value of the railway m the point of view of national dece.

hese four characteristics were dissed very fully, but we will only sum the main conclusions.

. — *Speed, regularity, and safety.*

r. REMY quotes, as an example in the e of passenger transport, speeds of km. (100 miles) an hour by railcar, 1 130 km. (81 miles) by heavy train r long distances.

le deals at some length with the ed of goods trains, an increase in h speeds requiring alterations to the gon rolling stock.

le considers that at the present time rts should be directed towards monising the equipment of marshalling ds by mechanizing them; generally aking the track layout and the perent way equipment should be imved and maintained unceasingly at high level required by present-day nands.

his raises the question of whether to 3 or even 4 tracks in the case of cerlines which have become inadete, or to build a completely separate ble track following a completely difnt alignment than the present track. e develops the idea of safety, ending 1 the problem of doing away with 1 crossings.

II. — *Comfort.*

r. REMY considers that whatever the hod of traction used : light or couplrailcars, steam or electric locomoti the fact that the rolling stock is led by the permanent way confers n this method of transport the possiy of obtaining the maximum com-

III and IV. — *Bulk transport; national defence.*

is the fundamental characteristic of railway that it can transport passengers and goods economically in bulk, a very outstanding advantage from the point of view of national defence.

The present tendency is to increase the number of trains whilst reducing their size.

The traffic of large centres and suburban areas is still best handled by underground or elevated railways.

The report contains a great deal of very interesting considerations of a general nature, particularly as regards the rates; the co-ordination of transport; the use of containers; the use of motor services in the case of certain lines showing a deficit; the part to be played by the railway in developing the Colonies.

Dr. REMY ends by expressing his conviction that the railway has an assured future as an essential factor in the trade between different States.

* * *

The problem of the rail from the metallurgical point of view,

by Dr.Ing. SCHULZ, of Dortmund.

What is expected of the rail under present-day conditions of operation, speed, and axle loads ?

First of all a high elastic limit, which is the characteristic of a hard metal with a high tensile strength. Then in order to be able to stand up to shocks and blows, the metal must be ductile, tough, and have a high elongation factor.

At first sight these different properties are irreconcilable, and herein lies the difficulty.

It therefore becomes necessary to compromise, especially as the rail must also show great resistance to surface wear, a characteristic which goes hand in hand with a high tensile strength and hardness.

During recent years considerable progress has been made in the investigation of fatigue tests under alternated loads.

Formerly the breaking of rails in service was a matter of great seriousness. This question now seems to have become one of much less importance, the number of such breakages having greatly decreased.

To sum up, the questions that remain to be solved by permanent way experts and metallurgists are the following :

— the measurement of the initial stresses in the track, their variation under atmospheric conditions, and particularly under temperature changes;

— the measurement of the actual stresses developed under moving loads;

— the possibility of welding, the ways of preventing wear of the running surface of the rail due to friction and shocks, either by the addition of manganese, or by perfecting the use of other alloys, or by heat treating the running surfaces;

— finally, the drawing up — in agreement with the metallurgists — of exact specifications for the inspection tests of rails at the rolling mills.

All these questions are treated in detail in Dr. SCHULZ's report.

We will content ourselves with quoting one of his conclusions which seems to us particularly interesting : that on the part played by phosphorus, which up to the present has been blamed for making the metal brittle.

Dr. SCHULZ considers that the most recent investigations carried out prove that fears on this ground are exaggerated.

He concludes his report by insisting on the necessity for collaboration between the railway engineers and the metallurgists of all countries in order to meet the present-day requirements of the railway.

RECENT DEVELOPMENTS
IN RAILWAY PRACTICE.

[625 .252 (.42)]

London and North Eastern Railway
New « Hook Continental » train.

It has for many years been the practice of the London and North Eastern Railway Company to provide new rolling stock in complete train sets for their important services, and a new train on modern lines has now been designed by Sir Nigel Gresley, C.B.E., the Chief Mechanical Engineer, and built at the York Works of the Company for the Hook of Holland Continental traffic between London, Liverpool Street and Parkeston Quay.

The new train, which is named the « Hook Continental » comprises eleven L. N. E. vehicles having seats for 84 first and 240 second class passengers. In accordance with the usual practice for Continental trains, two Pullman Cars seating 44 firsts are also included, the formation of the complete train from Liverpool Street being as shewn below :

	Seats.
Engine.	
Brake corridor second	36
Corridor second	42
Open second	48
Kitchen second	18
Open second	48
Open second	48
Open first	24
Kitchen first	12
Open first	24
Semi-open first	24
Pullman car « Irene »	22
Pullman car « Fortuna »	22
Brake van.	

The weight of the train including Pullman cars is 484 1/2 tons.

The service from London to the Continent leaves Liverpool Street Station at 8.15 p.m. every evening and the service in the opposite direction arrives in London at 7.53 a.m. The journey time between Parkeston and London is relatively short and as a large number of passengers desire to take meals during the journey the demand upon the restaurant-car service is very heavy. The train has, therefore, been provided with two kitchen cars with a considerable proportion of the seating accommodation in open vehicles, so that passengers may take their refreshment in the seats which they are allotted for the journey. A number of first and second-class corridor compartments are also available for passengers who do not wish to take meals and who prefer this type of accomodation.

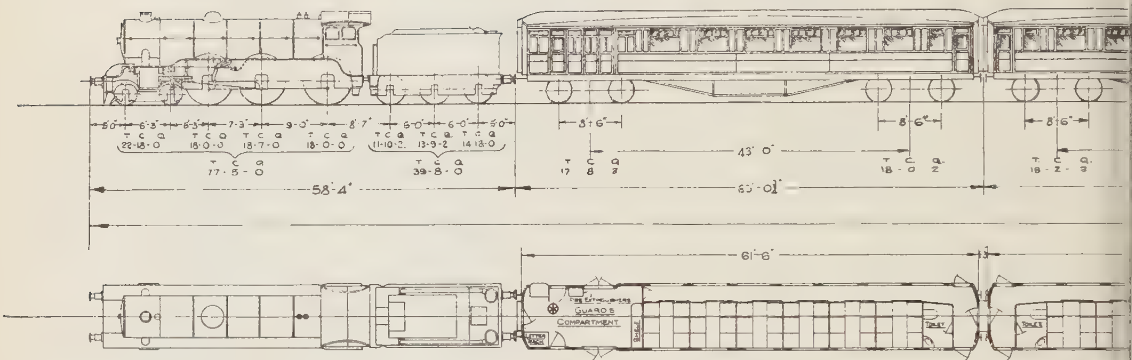
The coach bodies are built of teak and are mounted on steel underframes of welded construction, whilst compound bolster bogies ensure that the riding shall be of the high standard associated with the L. N. E. R. The whole train is coupled by means of buckeye automatic couplers connected to india-rubber springs, and the gangways between the coaches are Pullman vestibules.

To ensure a quiet interior the whole of the body sides and roof are insulated with asbestos acoustic blanket. Special attention has been given to the floors. In addition to a 1/2" sheet of sponge indiarubber under the carpet and hair felt between the floorboards, the whole of the underside of each vehicle has been insulated by means of sprayed asbestos

Type B 17.

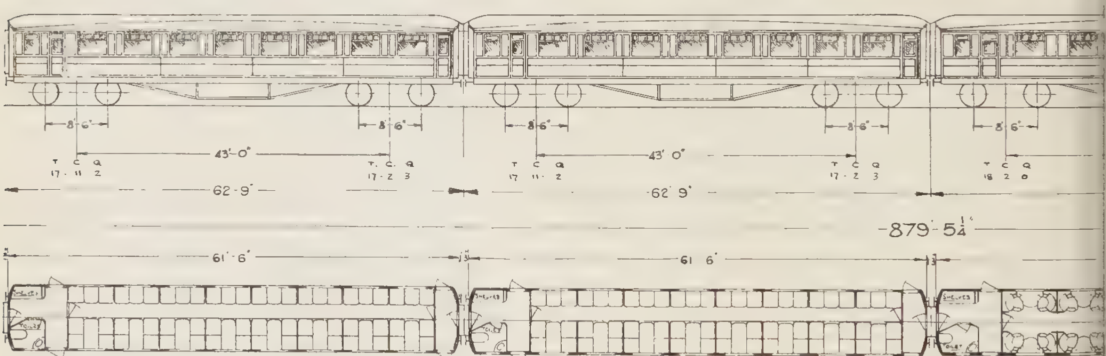
Corridor second brake.
36 seats.

Co



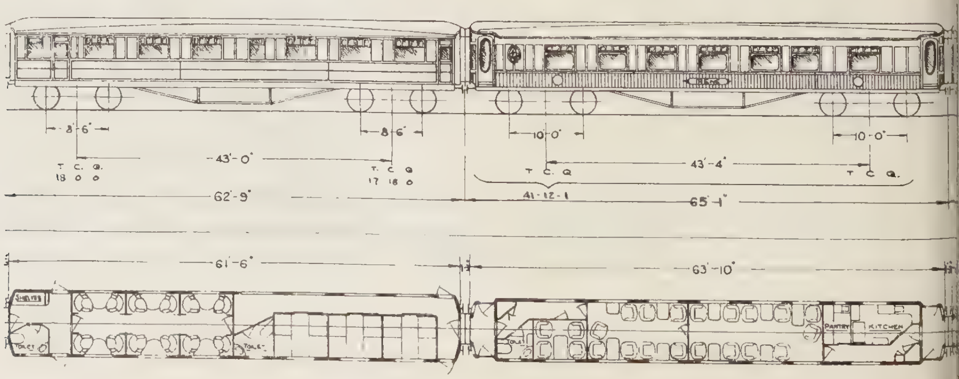
Open second.
48 seats.

Open second.
48 seats.

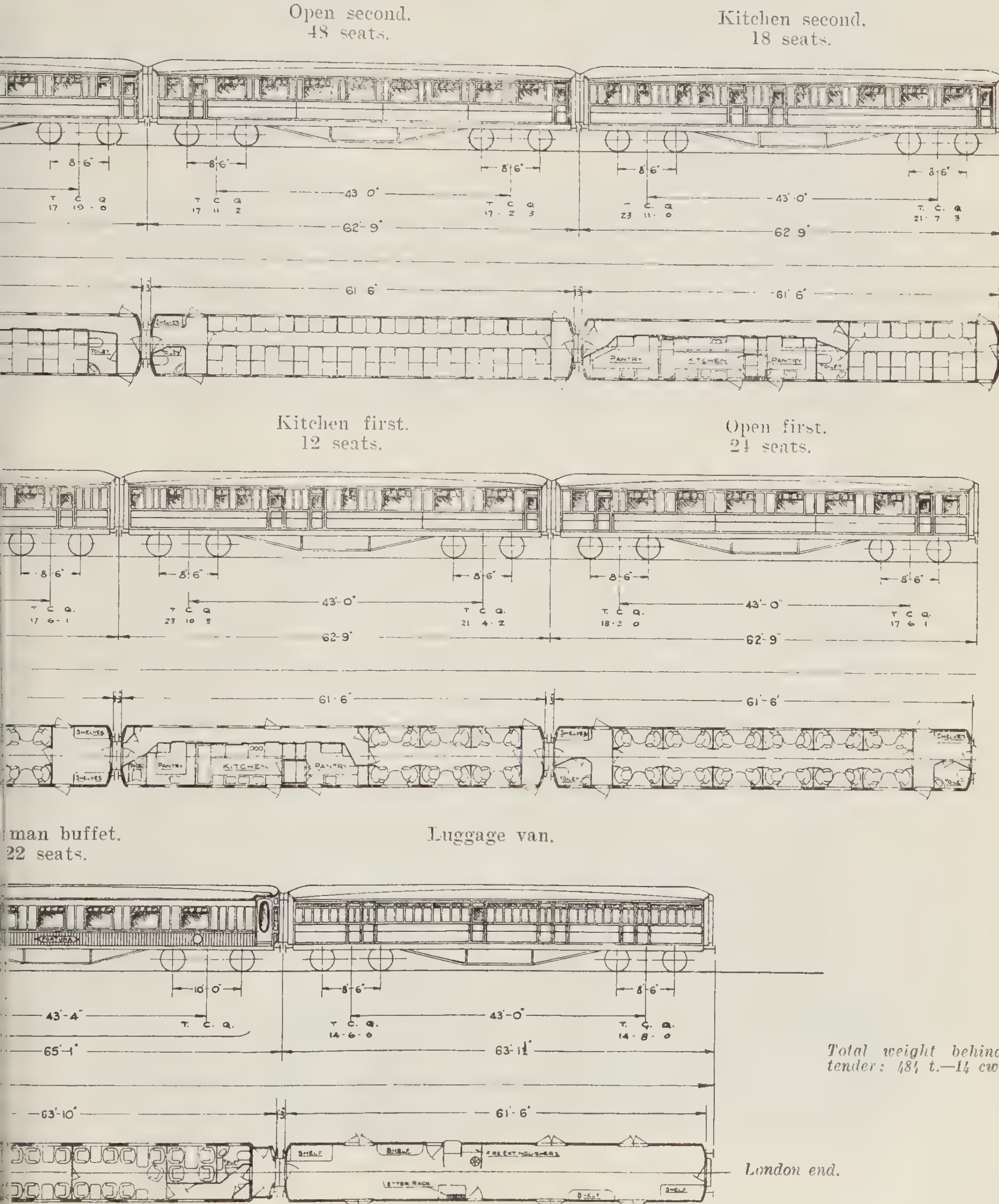


Semi-open first.
24 seats.

Pullman buffet.
22 seats.



London and North Ea



Hook Continental ».

supported on dovetailed steel sheeting. The sound proofing has been further enhanced by the interior finish employed, the whole of the inner walls and ceilings being covered in Rexine. The windows are formed of double glass with an insulating space between.

The whole of the seats on the train can be reserved and every effort has been made to provide the maximum possible comfort for the individual passenger.

The arrangement of the interior of the saloons is similar to that which was so successfully applied to the « Coronation » and « West Riding Ltd. » trains and gives the privacy usually associated with compartment carriages, whilst retaining the advantages and spaciousness of open vehicles. The first class saloons have been divided into sections by means of partitions, each section seating four passengers, two on either side of a central gangway, but no doors are provided except at the ends of the vehicles. The provision of ornamental screens projecting from the partitions gives an alcove effect.

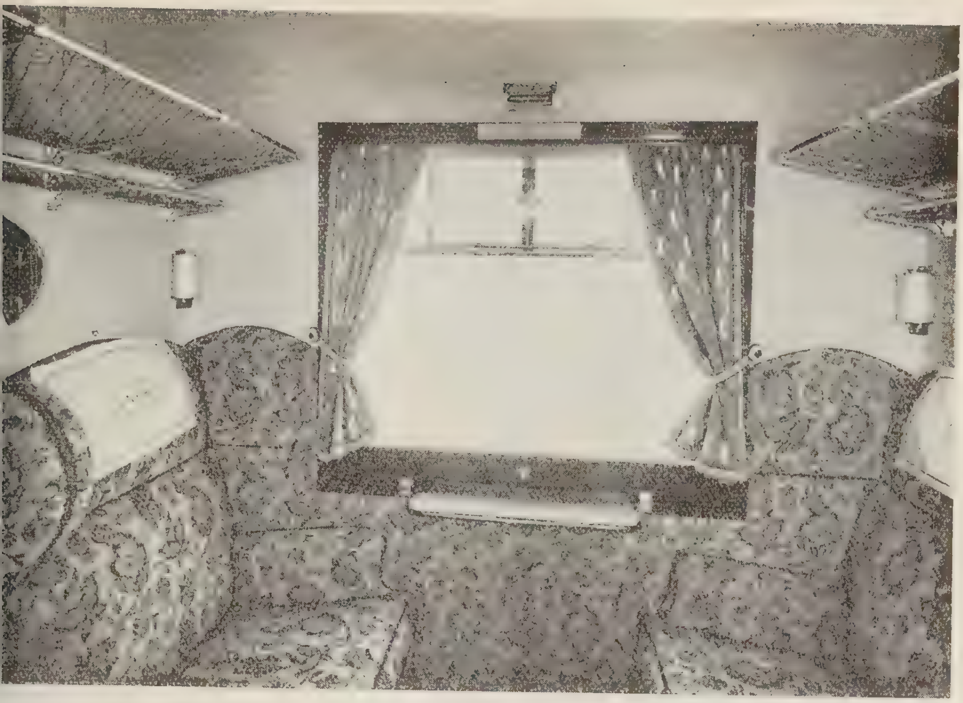
The arrangement of the first-class tables in the open vehicles is similar to Fixed tables are provided and the chairs are arranged to swivel, enabling the passenger to sit normally at the table at meal times and to turn away from the table when so desired. The tables are specially shaped to suit the swivelling chairs and the tops are covered with glass under which tapestry is placed to tone with the general scheme.

The interior decoration of the open first-class vehicles is similar to that adopted in the Coronation trains. The walls and roof are covered in Rexine, the lower portion being decorated by ornamental silvered nails forming a frieze and used in conjunction with an Alumilited aluminium moulding. The doors are likewise heavily studded with these decorated silver nails. The Rexine in the lower portion of this vehicle is of a dark green shade, whilst the upper portion of the walls and the ceiling are covered in light green Rexine. A plain Alumilited finish is also employed for the aluminium architraves at the doorways and for the decoration of the screens on each side of each doorway opening. The chairs are upholstered in green and fawn tapestry, the carpet being of a dark maroon shade. Each window is framed in black ebonised woodwork and is provided with curtains of silk brocade suspended behind a pelmet. Net racks of aluminium, designed to harmonise with the rest of the compartment, are fixed on the cross partitions. Single light corner fittings give an individual light to each passenger. A further lamp in an Alumilited aluminium fitting is provided in the centre of each section.

The second-class saloons are divided by cross partitions into sections of six passengers each. The upper portion of the walls and the ceilings are covered in stone coloured Rexine and the lower portion in Rexine having a shagreen finish. The junction is covered with an ornemental aluminium fret, the Rexine under portions of the fret being picked out in crimson. The doors which are of the darker Rexine are picked out in crimson and decorated in aluminium. The upholstery is of green and fawn uncut moquette whilst green carpets with red motifs are provided mounted as in the first class saloons on sponge rubber 1/2" thick. Four passengers are seated at one side of the gangway and two on the other in each section, and to facilitate movement in and out of the large seats the double tables are provided with hinged side flaps.

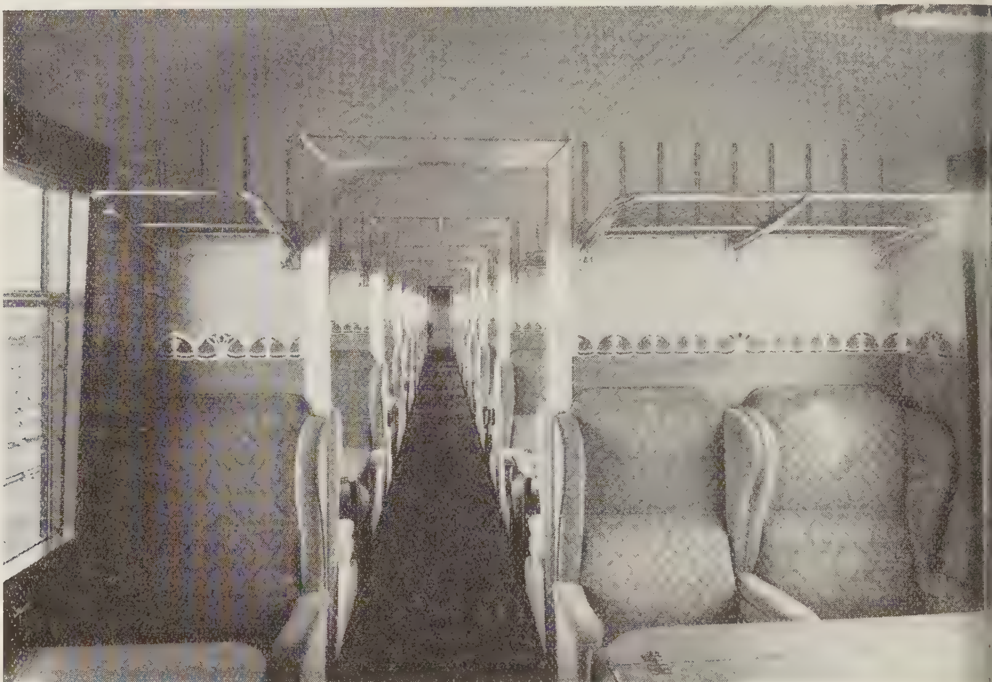
Lighting fittings similar to those in the first class compartments are provided, one lamp being fitted in each passenger section.

In order to facilitate the service of meals to all seats in the main portion of



Semi-open first class.

1st-class saloon.



Open second-class coach.

the train, two kitchens have been provided each equipped with electric cooking apparatus of the most modern type specially designed for this service by Messrs. J. Stone and Co. and supplied by Messrs. Henry Wilson and Co. of Liverpool. The equipment in both kitchens is identical and consists of the main cooking range, comprising roasting and steaming ovens, two grills and a boiling table having four hot plates. A separate fish fryer is also provided and a vegetable boiler is arranged near the electrically heated sinks on the body side. An automatic water boiler including coffee and milk urn, manufactured by Messrs. W. M. Still and Co., is arranged alongside the hot cupboard on the corridor partition and an automatic refrigerator, having separate compartments for iced wines, butter, cheese and general provisions, is also fitted.

The necessary power is obtained from two 10-kw. axle-driven generators suspended under each kitchen car in accordance with the L. N. E. R. standard practice and supplies power at 180-220 volts. An Exide-Ironclad double battery of 210 ampere-hours capacity is provided on each car for use when the train is standing.

The usual pantry accommodation is provided and in this connection it should be noted that the table linen, glass, crockery and silver is of distinctive design in keeping with the special character of the train.

A particular feature of the whole train is the wide corridors and ample circulating space at the ends of the carriages,

mitting easy circulation of passens joining and leaving, and recognis that passengers travelling on these ins will take more luggage than that uired for shorter journeys, luggage ks have been provided in the spaus entrance vestibules.

The first class lavatories are decorated green Rexine, coloured washbowls l hoppers being provided to match. e fittings are chromium plated and ull length mirror is also fitted. The water apparatus is heated by means steam in the winter time whilst in the mmer heat is obtained from an immer heater supplied from the train light dynamos. The floor is covered with rkoid to match the walls.

The second class lavatories are fitted in a similar manner, except that the prevailing tone is yellow.

The train is fitted with a system of ventilation and heating supplied by Messrs. J. Stone and Co., by means of which filtered air, heated to a comfortable temperature and thermostatically controlled, is introduced into the carriages at floor level and extracted through grilles in the lighting fittings in the roof. Ducts leading to large extractor ventilators enable the air in each vehicle to be completely changed every four minutes. Direct ventilation is also obtained by means of a sliding shutter ventilator above each side window.

The guards compartments at both ends of the train are fitted with the necessary switches for the control of the electric lights throughout the train.

MISCELLANEOUS INFORMATION.

[621. 135.2 & 625. 212]

I. — Methods of investigating cracks in axles,

by Mr. CONTE,
Honorary chief engineer of the Central Office for Rolling Stock Design (O. C. E. M.), France.

(*Revue Générale des Chemins de fer.*)

In the *Organ* of the 15th December, 1936, Herr König explains the investigations carried out concerning cracks in axles by means of two methods, i. e. the electrical method, and the magnetic method.

I. — Electrical test method.

(1) *Principle.* — If a continuous electric current passes through a shaft of uniform diameter and of homogeneous composition, the voltage drop is the same for sections of the same length. If at a certain point there is a crack, perpendicular to the centre line of the axle, the electrical resistance increases and the voltage drop is greater at this point. Cracks can, therefore, be discovered with the aid of a voltmeter included in the circuit.

(2) *Apparatus.* — A diagram of the apparatus is shown in figure 1.

A continuous current of 10 000 amperes produced by a low-tension generator (1 volt) is transmitted to the axle which has been previously insulated. The bars carrying the current are fixed on the end surfaces of the axle, which have been well polished beforehand. The contacts of the millivoltmeter are placed on the points to be measured, which must also be well polished. After the passing of the current the differences in voltage can be read on the millivoltmeter by using the commutator which is shown in figure 1.

A flaw at the wheel seat also produces a voltage drop and thus enables damage at this point to be detected. Suspicious axles are generally detected by electrical testing, whether it be a question of hot boxes having modified the structure of the metal, or of a crack in the journal.

Many carriage and wagon axles have been examined, but only one fracture was noticed. On the other hand, in the case of motor axles

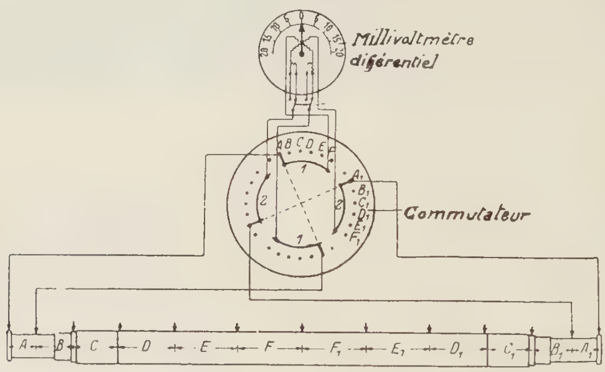


Fig. 1.

Note. — Commutateur = Commutator. — Millivoltmètre différentiel = Differential millivoltmeter.

railcars, driven by accumulators, which ry a load of 15 to 16 tons, many cracks e been found. The fact is that these axles particularly fatigued by the transmission the driving torque and cracks have often n found on the gear wheel seats.

'igure 2 shows the wiring diagram for the trical test of a motor axle. The continu- current of 10 000 amperes is transmitted the axle as mentioned previously.

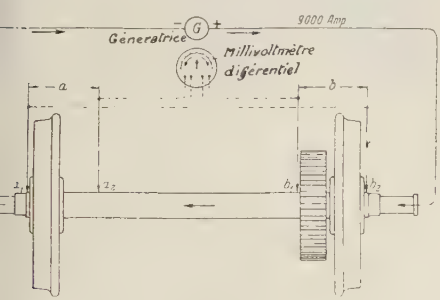


Fig. 2.

Note. — Génératrice = Generator.

'ith the amperage normally used the de- ion with a motor axle with the gear wheel in perfect condition is approximately 1 3 to 6 millivolts. If the pointer re- ns in the « O » position, or has moved than 3 millivolts, the seat of the gear el is suspected to be defective.

1e suspected axles are thoroughly examin- and the gear wheels taken off. The axle hen tested alone by the same process in r to discover the cracks.

his is a simple method of detecting cracks it is necessary to complete the investig- n by the electro-magnetic test.

II. — **Electro-magnetic test method.**

) *Principle.* — The lines of force in the of magnetically saturated metal are de- d when passing a crack for, at this point, reduced section produces magnetic super- ation. This phenemenon is revealed by ing, on the specimen to be tested, iron s which will arrange themselves in a ike formation on the crack.

(2) *Apparatus* (figs. 3 and 4). — The testing appliance comprises an electro-magnetic core with exciting coil and magnets, the core and the coil being placed underground and covered by flagstones. The exciting current forces the core against the ends of the axle, which must be perfectly level and polished.

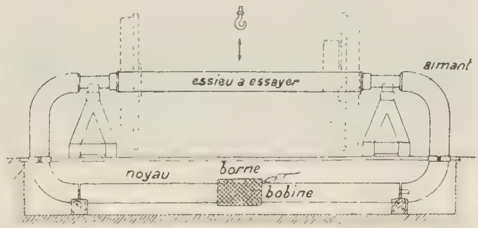


Fig. 3.

Note. — Essieu à essayer = axle to be tested. — Aimant = magnet. — Noyau = core. — Bobine = coil. — Borne = terminal.

The amperage required for the exciting current depends upon the diameter of the parts to be examined. The degree of saturation is reached when the filings, distributed over the suspected area, can be removed by blowing with a small blower or even with the mouth.

With some experience, the nature and depth

Fig. 4.

of a crack can be ascertained from the thickness and form of the filings.

Cracks occurring at the wheel seat cannot, of course, be discovered by this method.

III. — **Results obtained with the two processes.**

For the past three years all railcar motor

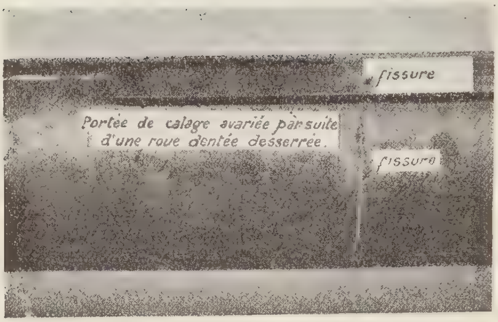


Fig. 5.

Note. — Fissure = crack. — Portée de calage avariée = wheel seat damaged through the loosening of a gear wheel.

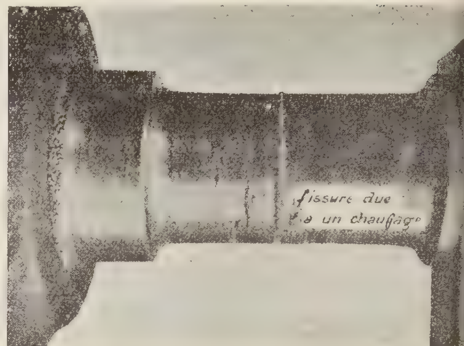


Fig. 6.

Note. — Fissure due à un chauffage = crack due to overheating.

axles have been tested as well as carrying axles subjected to great stress.

Of 200 axles tested by the electrical process, 25 motor and 2 carrying axles were suspected as being defective. These axles were then tested by the magnetic testing apparatus after the wheels had been removed. 20 axles were found to be cracked, the depths of the cracks varying from the thickness of a hair to 10 mm. (3/8"), sometimes even to 30 mm. (1 3/16") and their length sometimes extended round the shaft. On the seven other broken axles, keyways and wheel seats in bad condition were found, both defects being causes of subsequent cracks. Figure 5 shows an example of a damaged axle, and figure 6, the crack of an axle which had been overheated.

It appears that the use of these two methods would involve fairly heavy expenditure on equipment.

[585. 072 (.42) & 698 (.42)]

2. — Paint research on the London Midland and Scottish Railway.

(*The Railway Gazette.*)

Mr. Frank FANCUTT, Paint Technologist, Research Department, L. M. S. R., read a paper on April 5 to the Institution of Civil Engineers in London on the work of the paint research laboratory of the L. M. S. R. In 1864, he said, the first of the chemical laboratories of the constituent companies of the L. M. S. R. was opened at Crewe, and, by the end of the nineteenth century, they were all equipped with some form of chemical testing laboratories. In 1932, the chemical, paint, metallurgical, and engineering laboratories of the L. M. S. R. were grouped into an independent Research Department, and the provision of a building, opened at Derby by Lord Rutherford in 1935, to house the new department, was the culminating development. The chemical laboratories are, however, still located at the Company's main works.

There is no other single material used by the railway of greater importance than paint and, as Mr. Fancutt explained, work in the paint laboratory is done on behalf of every department of the Company in one form or another. The work of the laboratory is divided into three sections, one concerned with rou-

e testing and control of supplies as well the problems relating to the development l manufacture of cleaning solutions; the ond dealing with the development of new cesses, problems concerned with applica-ı, the control of trials and the investiga-ı of abnormal failures; and, thirdly, the earch section which concentrates on the ıtion of unusual problems and the deve-ment of new materials and methods of test. research department co-operates with the nt industry, and far-reaching developments probable as a result.

he drafting of paint specifications is the ponsibility of the paint laboratory, after ch they are approved by the using and es departments. Mr. Fancutt went on to ribe tests and methods of control, em-sising the importance of physical testing. e the properties of adhesion, strength to ıd up to traffic conditions and abrasions resistance to moisture cannot be deter-ed by chemical means. Physical testing achieved by ingenious apparatus mostly e by the laboratory which was described ı the aid of lantern slides. An investiga-is now proceeding on accelerated weather-The advantage of the experience gained physical testing has already found outlet he specifications controlling the purchase nd supplies of synthetic resin enamels for al arms and synthetic resin clear varnis-for finishing locomotives and carriages.

fter reviewing the qualities and proper-of oil paints and synthetic painting ma-ıls, the author described developments in painting of rolling stock with particular ence to the precautions necessary in lling and preparing steel panels for loco-ves and carriages. The latter are treated ally with a panel wash and immediately eafter given a coat of paint. For locomo-tenders, sand blasting and shot blasting increasingly used, as well as treatment flexible discs coated with very coarse prundum paper.

nerally, in the past more paint has been ed to rolling stock than was necessary, as many as 17 coats were applied by the L. M. S. R. until ten years ago for a railway carriage. The practice now standardised after much careful research involves the application of 11 coats and the time required for actual painting has been reduced by 30 per cent. With this the durability of the coating has actually been increased. To improve the maintenance of the painted surface a waxing composition is applied to practically the whole of the locomotive and carriage stock of the L. M. S. R. four times per annum, by which the life of the paint work has been extended by more than 50 per cent. Two types of waxing composition are in general use, one being applied to the rolling stock immediately after it is finished in the works, and the other after the carriages have been in service.

Experiments are well on the way to completion which should lead to a further reduction in the number of coatings through the use of the nitrocellulose-synthetic resin process and also through modifications of synthetic resin enamels. The Coronation Scot train was treated with this newest type of finish and experience with it goes to show its superiority.

The interior decoration of carriages has also been carefully studied. Early experiments with various types of cellulose finishes were eventually standardised and form the basis of the present L. M. S. R. cellulose specifications. Newer developments have called for the introduction of quick-drying synthetic resin finishes, and combinations of varying types of cellulose in conjunction with synthetic resins. These show promise of producing more durable films and lend themselves more readily to renovation. The question of renovation has been the subject of a series of experiments, the result of which was evolution of a refiner that has proved entirely satisfactory. An efficient stripping material has also been evolved.

In dealing with the painting of structures, Mr. Fancutt emphasised the importance of thoroughly cleaning steel-work before the application of paint. Wire brushing, hammering, and descaling by pickling, as well as sand blasting, shot blasting, and grinding, are the

methods most favoured. He also emphasised the importance of painting only under suitable atmospheric conditions. The author concluded with a review of paint spraying, and stated that the L. M. S .R. is at present using this method in the painting of wagons, road vehicles, stations, and structures, as well as in the application of cellulose finishes in the interiors of carriages. The author had organised a school for spray painters which had fully justified itself, as the proper application of this method is of vital importance.

[621. 43]

3. — Large diesel locomotives.

(*Diesel Ry. Traction*, Supplement to *The Railway Gazette*.)

There has been a noteworthy tendency during the past twelve months to develop the large diesel locomotive to powers of 1 800 B.H.P. and over, a tendency which is in contrast to the hitherto general and as yet unabated progress of the multi-unit set train for main line work, as exemplified by the Flying Hamburger.

It appears that as far as non-American practice is concerned, the culmination of the first stage in the construction of super-power diesel locomotives has been reached with the trials just concluded of the new Sulzer 4 000-B.H.P. locomotive for the Roumanian State Railways, and the virtual completion of the second P. L. M. 4 000-B.H.P. locomotive. No further locomotives of anything like this power are now under construction in Europe, although the Norwegian Parliament has authorised the purchase for the Oslo-Bergen line of a 4 000-B.H.P. diesel-electric unit by the State Railways.

Further development will probably await at least a year's regular running, and in this connection it is encouraging to note the reasonably successful operation of the first P. L. M. 4 000-B.H.P. locomotive since the summer of last year. Athough it has not been included in any of the regular rosters, it has worked many thousands of miles on normal passenger trains, and we believe it is the intention to introduce it into regular service with the inauguration of this summer's timetables. Certain troubles have arisen in the electrical equipment and in the auxiliaries, but have not been regarded as indicating anything serious in the design or construction. Benefit might well be taken of experience with large diesel locomotives in America, where there are over a score of locomotives of 1 800 to 3 600-B.H.P., some of which have been at work for over two years.

Invariably the super-power main-line diesel locomotive is a twin-unit design, frequently with each half a duplicate of the other. The largest single-unit diesel locomotive of entirely separate construction has one ten-cylinder, 2 000-B.H.P. Busch-Sulzer two-stroke engine and is used for heavy short-distance freight trains. Above that power, all the diesel locomotives operate in fast passenger service, except that the Roumanian locomotive will handle both passenger and freight trains over the mountainous and sharply-curved main line from Campina to Brassov. Both of the P. L. M. locomotives are composed of two similar portions, each with the 4-6-4 wheel arrangement, but whereas the Sulzer locomotive has in each half a twin-bank 2 200-B.H.P. engine driving a single d.c. generator through step-up gearing, the M. A. N.-engined locomotive has in each half a twin-bank engine of 2 200-B.H.P., each bank of which drives a separate generator. The continuous output per engine is 1 900 B.H.P. and the engine speeds permitted by the directly-regulated electric control system (with automatic controllers of the Simplex Cuénod type) are 420, 500, 630, and 700 r.p.m.

Electric transmission is still universal, usually with the incorporation of nose-suspended motors having flexible gear wheels, but some-

with an individual axle drive of one or of the cup spring types. As a result of eneral operation in passenger service, the ing tractive effort is not unduly high, the engine output is used to maintain starting effort up to a relatively high- — 25 m.p.h. in the case of the P. L. M. otive. Auxiliary drives and power ar- ments have in general followed the pre- practices, as applied to 1 200-1 500-B.H.P. otives, but in America the position has complicated by the increased lighting, ng, and air-conditioning load of long s, and separate auxiliary sets, up to a of four of 50 kW. each, have been in- d. In both European and American prac- the number and variety of the auxilia- generally cause more trouble and expense, are responsible for more maintenance ges than either the main power plant or mechanical portion.

percharging by exhaust-gas turbo blow- as been the greatest single step to mak- super-power diesel locomotives a practi- proposition for British and Continental tions. For a weight increment of 8 to r cent., and a price increase of nearly ame order, the continuous power output e raised by 35 to 40 per cent. with prac- y no additional complication and with- dding to the cooling equipment. More- this increment is obtained without ad- to the bulk of the power plant, a critical tage which enables a 2 000-B.H.P. engine mounted comfortably within the limits loading gauge.

By the use of the exhaust gas supercharger in conjunction with a four-stroke engine, the weight of diesel locomotives in full working order has been brought down as low as 115 lb. per B.H.P. In the non-supercharged two-stroke American locomotives the weight is 124 to 145 lb. per B.H.P. when stainless steel is used for the body construction.

European and American high-power diesel locomotives, apart from the prevalence of the twin-vehicle formation, offer a series of contrasts in their design. In Europe two four-stroke supercharged engines, each of great-power are incorporated; in America three to six non-supercharged two-stroke engines are used for powers of 3 000 B.H.P or more, and two for 1 800 up to 3 000 B.H.P. The use of the two-stroke Winton engine of 900 or 1 200 B.H.P. probably was dictated by the desire to use an existing engine and thus eliminate a period of experimental running and obviate any delay waiting for spare parts. But it leads to complication, and in the new triple-unit 5 400-B.H.P. locomotives of the Union Pacific Railroad there are 72 sets of cylinders and driving sets compared with 24 sets on the P. L. M. 4 000-B.H.P. locomotive. Auxiliaries are provided with power by separate small engine-generator sets in American locomotives, whereas elsewhere the general practice is to have an auxiliary generator working from the main generator shaft. Finally, in Europe the locomotive is built on a rigid frame construction, whereas in the U. S. A. the double-bogie type is used exclusively.

NEW BOOKS AND PUBLICATIONS.

[385. 15 (.42) & 656 (.42)]

Nationalisation of transport. An impartial review. — 1938, London; a pamphlet (7" × 4 3/4") of 76 pages. — Published by the Modern Transport Publishing Co. Ltd., Norman House, 105-109, Strand, W. C. 2. (Price : 1 sh. net.)

This pamphlet is a re-issue of a series of articles, from the well known English periodical *Modern Transport*, written with the object of presenting an objective review of the question of the nationalisation of transport undertakings.

The question has often been raised in Parliament during the last century, as well as in the press, and recently it has also been discussed at professional assemblies and by study groups. It has given rise to a great deal of literature. The difficulty is to get an impartial examination of the facts out of all this mass of information, and bring out the arguments for and against it, taking into account the economics of transport and its carrying out, whilst at the same time respecting commercial and social exigencies.

The author examines in turn the different aspects of nationalisation. First of all he considers the criticisms levelled against the railway and decides whether they are justified, and if so, to what extent. This leads him to review the position of the railways and the way in which they fulfil their mission. He also explains their financial position. Other transport undertakings, municipal and otherwise, are dealt with in the same way.

Road competition is also an important factor that must be taken into account, as it has exercised a great influence on railway transport, and it was found necessary to analyse the measures taken by the railway companies and the public authorities in the face of the evolution of road transport.

What would be the essential characteristics of the reform in question, and what would be its extent, i. e. to what transport undertakings would it apply? This is what the author tries to elucidate, based on the discussions it has given rise to and the declarations of its partisans on the one hand, and on the other by taking into account the extent to which it would be possible to realise it. He then examines at length the following points which appear to dominate the whole question : the new organisation, the spirit in which transport would be operated and the possible results, the advantages expected and their repercussions, and the possible drawbacks.

Lord Stamp, the eminent President of the Executive of the London Midland and Scottish Railway, has written a short preface to the pamphlet, in which, after clearly ennunciating the question, he expresses the opinion that a very useful task has been accomplished by *Modern Transport* in making this impartial enquiry, and that the publication of this little book will throw light on this important and highly controversial subject. E. M.

[621. 43 (02]

Dr.-Ing. Techn. Otto JUDTMANN. — **Motorzügforderung auf Schienen** (Railway traction by means of internal combustion engines). — One volume (9 1/2" × 6 1/4") of 286 pages with 108 figures. 1938, Vienna, Julius Springer, publisher. (Price : 24 Rm.)

Railcars with internal combustion engines have rapidly gained an important place in railway operation; the manufacturers and the railway officers have to an ever increasing degree to deal with traction problems due to the use of this type of stock. The technical press certainly has published a great deal of information about this subject, but such articles frequently merely des-

[a]re these motor vehicles; the traction [pro]blems properly speaking are only [tou]ched upon, or else they are the sub[jec]t of special studies scattered here and [the]re in the technical press.

[D]r. JUDTMANN's work gives us a me[tho]dical and very complete report on [all] the traction questions raised by the [use] of vehicles with internal combus[tio]n engines, from shunting locomotives [of s]mall power to powerful motor trains; [eac]h part of his book includes, in addi[tio]n, the data required really to under[sta]nd the traction problems properly [spe]aking.

[T]he first three chapters form an in[tro]duction dealing with the history of [the] evolution of stock drawn by inter[nal] combustion engines, a methodical [cla]ssification of the various types of [sel]f-propelled vehicles, and the position [of] such stock in countries where it is [no]w rather widely used.

[I]n Chapter IV, the fundamental prin[cip]les of the traction problem are con[sid]ered by investigating the questions [of] resistance, power, adhesion, etc...; [thi]s is followed by a chapter devoted to [the] internal combustion engine itself, [whi]ch includes in particular a remark[abl]y methodical comparison of the pro[per]ties and peculiarities of the working [of] petrol and diesel engines.

[A]n important part of the book is de[vot]ed to the transmission question, es[pec]ially from the point of view of de[ter]mining the traction characteristics of [the] internal combustion engine under [diff]erent power outputs; when describ[ing] the various kinds of drive, the [auth]or limits himself to giving particul[ars] of one or two of the most typical designs. In the case of electric transmission in particular, he gives the essential working principles of the generator and traction motors; he then examines the adaptation of the characteristics of the power generator to that of the heat engine, as well as the relative operating conditions of the traction motors and the generators.

The book then deals with the accelerating power and ability to climb gradients, as well as the establishment of the characteristic curves for starting, running, and braking; the author gives in particular the various graphical methods or calculations used to plot these curves. The methods for calculating the fuel consumption with the various drives and under various running conditions are then given; the traction characteristic curves at various powers are completed by the corresponding fuel consumption curves; the author gives an approximate formula for calculating the fuel consumption in relation to the tonne-kilometre; he compares the results given by this formula with those given by the traction curves and by actual road tests.

Important chapters deal with engine tests on the test bench and on the line; with narrow-gauge stock and shunting locomotives; and with the calculation of the cost of traction by internal combustion engines. The end of the book is devoted to the future of railcars and diesel locomotives.

To sum up, Dr. JUDTMANN's book is a very valuable source of information and will be a very great help to builders and railway engineers when considering this new method of traction. A. C.

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[6]21. 13 (.02) & 621. 137 (.02)]

[NI]EDERSTRASSER (L.), Reichsbahnrat. — **Leitfaden für den Dampflokomotivdienst** [(]*Manual for the steam locomotive staff*). — One volume ($8\frac{1}{4}$" × 6") of 456 pages with [4]19 figures and 8 appended tables. — 1938, Leipzig, Verkehrswissenschaftliche Lehrmit[t]elgesellschaft m.b.H. (Price : 6.40 Rm.).

[In] the December 1935 issue of the [Bull]*etin,* we reviewed the first edition of Herr Niederstrasser's manual for the steam locomotive staff, making partic-

ular mention of its new features from the educational point of view, and of the special care devoted to the diagrammatic illustrations of locomotive parts.

A second, completely revised and augmented edition of this manual has now been brought out. The additions include the question of streamlining high-speed locomotives, the increased use of welding in the construction of locomotives and tenders, the use of roller bearings, the adaptation of the brakes to the new speed conditions, and a description of recent improvements to the brake-gear : Knorr automatic driver's brake valve, new types of Hildebrank-Knorr brakes, etc. The chapters devoted to locomotive shed equipment have also been revised and extended. This new and carefully prepared edition of this excellent manual will certainly prove as popular as the earlier edition.

A. C.

[621. 13 (.494)]

A. MOSER, former engineer of the Swiss Federal Railways. — **Der Dampfbetrieb der Schweizerischen Eisenbahnen** (*Steam traction on the Swiss Railways*), 2nd revised edition. — One volume (12" × 9 ¼") of 394 pages, with 26 tables and 336 figures. — 1938, Basle. Published by E. Birkhäuser & C^ie^, 15, Elisabethenstrasse. (Price, bound : 22 Swiss francs).

Mr. MOSER's object in writing this book was to give the whole history of the evolution of the steam locomotive on the Swiss railways from the opening of the first line in 1847 until the present day. The first edition appeared in 1923; at that time already the author considered he was undertaking a useful task in publishing the very complete data he had collected on this subject; the rapid extension of the electrification of the Swiss railways made it appear likely that steam operation would gradually be given up in the near future, so that it was of value to record the detailed information and historical documents that otherwise might easily have been lost.

At the present time the number of steam locomotives on the Swiss railways is less than half what it was in 1923; this has enabled the author in publishing the revised and extended second edition of his book to look upon the history of the Swiss steam locomotive as a question that has already reached its full development.

After an introduction devoted to the origins of the Swiss railway system and its present constitution, the author examines the situation of the stock of steam locomotives as a whole from the point of view of their technical evolution. He then traces in detail the history of the various types used by the five principal companies operating the system until it was taken over by the State in 1898, and the Swiss Federal Railways formed. The types introduced by this System are then considered in detail, including in particular the special types of locomotives recently tested, one being a turbine locomotive, and the other a high-pressure locomotive. His usual practice is to give a photograph and diagram for each type of locomotive, together with the year of construction, the builder, numbers and variations of the stock, the leading dimensions and characteristics, the technical features any modifications made, the date certain locomotives were transferred or scrapped, etc.

The final chapters are devoted to the steam locomotives of the many secondary Swiss lines, both standard and narrow gauge, and those of the rack railways.

The care taken in the writing and presentation of this book make it rank amongst the best works on the history of steam locomotives, and its publication will certainly be received with enthusiasm by all the « friends of the locomotive ».

A. C.

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P. GHILAIN,

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AURENGE. — Le **cahier des charges** des lignes exploitées par la Société Nationale des Chemins de fer français. (5 300 mots.)

1938 621 .132.8 (.44) & 621 .43 (.44)

Revue générale des chemins de fer, mai, p. 277.

TOURNEUR. — **Locomotives Diesel électriques** à grande vitesse de la Société Nationale des Chemins de fer français. (3 200 mots & fig.)

1938 625 .1 (.44)

Revue générale des chemins de fer, mai, p. 287.

HABOUZIT. — Le **raccordement** de Valenton. (4 000 mots & fig.)

1938 624.

Revue générale des chemins de fer, mai, p. 299.

SECKLER (G.). — Un **grand pont sous rails** quilles, près de Strasbourg. (1 400 mots & fig.)

1938 669 &

Revue générale des chemins de fer, mai, p. 313.

Le **torstahl.** (500 mots & fig.)

Revue universelle des Mines. (Liége.)

1938

Revue universelle des mines, mai, p. 366.

MORESSÉE (G.). — **Rapidité d'échauffement** **refroidissement d'un métal.** (5 000 mots & fig.)

1938 62

Revue universelle des mines, mai, p. 375.

HANOCQ (Ch.). — Etude théorique et expéri tale des **paliers lisses** et des **paliers à billes.** (7 800 & fig.)

1938 62.

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BRASSEUR (H.). — Les applications industrielle **rayons X.** (1 500 mots.)

Traction nouvelle. (Paris.)

1938 621 .43

Traction nouvelle, mai-juin, p. 70.

CHATEL (M.). & BONDON (G.). — La missi MM. Chatel et Bondon aux Etats-Unis. Utilisati entretien des **trains Diesel américains.** (7 000 m fig.)

1938 621 .43

Traction nouvelle, mai-juin, p. 86.

ROY (M.). — La **station d'essai des autora** Dietrich à Reichshoffen. (1 500 mots & fig.)

1938 621 .43

Traction nouvelle, mai-juin, p. 88.

Présentation d'un **nouvel autorail à gazogène.** mots & fig.)

In German.

Die Lokomotive. (Wien.)

1938 621 .132.3

Die Lokomotive, April-Mai, S. 58.

2-D-2 Heissdampf-Schnellzugslokomotive der nischen Staatsbahnen für 1 676 mm. Spurweite. Wörter & Abb.)

38 **621 .43 (.436) & 625 .26 (.436)**
Lokomotive, April-Mai, S. 63.
chnische Fortschritte bei den Österreichischen B. B.
0 Wörter & Abb.)

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38 **621 .132.8 (.44) & 621 .43 (.44)**
Lokomotive, April-Mai, S. 67.
Co2 + 2 Co2 Diesel-Elektrische Lokomotive der
M. (1 500 Wörter.)

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38 **621 .132.5 (.81)**
Lokomotive, April-Mai, S. 69.
**terspurige 1E1 Heissdampf 3 Zyl. Güterzugloko-
ve** der Sorocabana-Eisenbahn in Brasilien. (1 900
er & Abb.)

Die Reichsbahn. (Berlin.)

38 **385 .586 (.43)**
Reichsbahn, Heft 18, 4. Mai, S. 469.
EOBALD. — **Lehrlingsrecht** bei der Deutschen
sbahn. (8 500 Wörter.)

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38 **385 .113 (.43)**
Reichsbahn, Heft 19, 11. Mai, S. 490.
RPMÜLLER. — **Geschäftsbericht** der Deutschen
sbahn über das Geschäftsjahr 1937. (8 300 Wörter.)

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38 **656 .212.9 & 656 .235**
Reichsbahn, Heft 19, 11. Mai, S. 502.
RNACK. — Der **mechanische Frachtsatzzeiger.**
0 Wörter & Abb.)

Elektrische Bahnen. (Berlin.)

38 **621 .335 (.43)**
rische Bahnen, Märzheft, S. 52.
SCHINGER (O.). — **Dreiteiliger Einheits-Wech-
omtriebzug** für 120 km/h. — I. Wagenbaulicher
(6 400 Wörter & Abb.)

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38 **621 .335 (.43)**
rische Bahnen, Märzheft, S. 62.
IFFLER (A.). — **Dreiteiliger Einheits-Wechsel-
triebzug** für 120 km/h. — II. Elektrischer Teil.
0 Wörter & Abb.)

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8 **621 .335 (.494)**
rische Bahnen, Märzheft, S. 69.
EINER (F.). — Die **Schnelltriebzüge** der Schwei-
hen Bundesbahnen. (6 900 Wörter & Abb.)

Glasers Annalen. (Berlin.)

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s Annalen, Heft 8, 15. April, S. 95.
IFFLER. — Der **Personen-Schnellverkehr** der
chen Reichsbahn unter besonderer Berücksichti-
der **Triebfahrzeuge.** (7 700 Wörter & Abb.)

Organ für die Fortschritte des Eisenbahnwesens. (Berlin.)

1938 **624. (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 9, 1. Mai, S. 166.
TILS. — **Eisenbahnbrücken** im Rheinland zwischen Koblenz und Kleve. (3 500 Wörter & Abb.)

1938 **656 .253 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 9, 1. Mai, S. 172.
HARTMANN (F.). — Die **Deckungs- und Gleisfreimelderanlage** in Köln Hauptbahnhof. (2 000 Wörter & Abb.)

1938 **725 .3 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 9, 1. Mai, S. 176.
JÜSGEN. — 99 Jahre **Eisenbahnhochbau** im Bezirk der Reichsbahndirektion Köln. (2 400 Wörter & Abb.)

1938 **621 .43 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 9, 1. Mai, S. 181.
HIPP. — Die **Triebwagenabstellanlage** bei Dortmund. (3 500 Wörter & Abb.)

1938 **621 .43 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 10, 15. Mai, S. 187.
TASCHINGER (O.). — **Diesel-Aussichtstriebwagen.** (7 500 Wörter & Abb.)

1938 **621 .43 (.43) & 625 .25 (.43)**
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RÖBLING. — Die **Bremse des dieselhydraulischen Aussichtstriebwagens.** (3 300 Wörter & Abb.)

Zeitschrift des Vereines deutscher Ingenieure (Berlin.)

1938 **531**
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RAUSCH (E.). — **Federnde Lagerung** von Maschinen. (5 600 Wörter & Abb.)

1938 **625 .245 (.43)**
Zeitschr. des Ver. deutsch. Ing., Nr. 17, 23. April, S. 509.
WALDSTÄTTEN (K. v.). — **Tiefladewagen** von 200 t. Tragfähigkeit. (1 300 Wörter & Abb.)

1938 **621 .131**
Zeitschr. des Ver. deutsch. Ing., Nr. 18, 30. April, S. 515.
NORDMANN (H.). — Der **Leistungsgewinn von Stromlinienlokomotiven.** (6 400 Wörter & Abb.)

1938 **721 .1**
Zeitschr. des Ver. deutsch. Ing., Nr. 18, 30. April, S. 522.
LANGE (O.) & BAENISCH (K.). — **Einfluss wechselnder Wasserstände** auf die Höhenlage von Festpunkten und Bauwerken. (2 000 Wörter & Abb.)

1938 **624. (.43)**
Zeitschr. des Ver. deutsch. Ing., Nr. 18, 30. April, S. 526.
Grundsätze für die bauliche Durchbildung **stählerner Strassenbrücken.** (800 Wörter.)

1938 **625 .62**
Zeitschr. des Ver. deutsch. Ing., Nr. 18, 30. April, S. 532.
Dreiachsige Fahrgestelle für Strassenbahnen mit gesteuerten Endachsen. (700 Wörter & Abb.)

1938 **621 .134.1**
Zeitschr. des Ver. deutsch. Ing., Nr. 19, 7 Mai, S. 541.
LEHR (E.). — Dynamische Dehnungsmessungen an einer **Lokomotiv-Pleuelstange.** (3 200 Wörter & Abb.)

1938 **531**
Zeitschr. des Ver. deutsch. Ing., Nr. 20, 14. Mai, S. 569.
ALLENDORFF (F.). — Messverfahren zur einfachen Bestimmung von **mechanischen Schwingungen.** (4 000 Wörter & Abb.)

1938 **62. (01**
Zeitschr. des Ver. deutsch. Ing., Nr. 21, 21. Mai S. 614.
GRAF (O.). — Aufgaben der **Werkstofforschung** und **Werkstoffprüfung.** (4 500 Wörter & Abb.)

Zeitschrift für das gesamte Eisenbahn-Sicherungs- und Fernmeldewesen. (Berlin.)

1938 **656 .211.5**
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REINHARD (K.). — **Bahnhofs-Lautsprecheranlagen.** (2 700 Wörter & Abb.)

1938 **656 .25**
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FEHLAUER (P.). — Das **Federspannwerk.** (1 900 Wörter & Abb.)

Zeitung des Vereins mitteleuropäischer Eisenbahnverwaltungen. (Berlin.)

1938 **656. (.44)**
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 17, 28. April, S. 319.
BERCHTOLD (W.). — Die Entwicklung der **Verkehrsteilung zwischen Schiene und Strasse** in Frankreich. (4 600 Wörter.)

1938 **385. (.51)**
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LOCHOW (v.). — Das Jahr I des **Fünfjahresplans des Chinesischen Eisenbahnministeriums.** (2 300 Wörter.)

1938 **385 .113 (.481)**
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 17, 28 April, S. 328.
Die **norwegischen Eisenbahnen** 1936-1937. (1 000 Wörter.)

1938 **656. (**
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr
12. Mai, S. 357.
BERCHTOLD (W.). — Die Entwicklung der **Verkehrsteilung zwischen Schiene und Strasse** in Fr
reich. (4 200 Wörter.)

1938 **621 .135.4 & 625**
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr
19. Mai, S. 377.
DRECHSEL (A.). — Die **Lösung der Schnellverk
frage durch den kurvenneigenden Kreiselwagen.** (
Wörter & Abb.)

1938 **385. (07.2)**
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr
19. Mai, S. 385.
STIELER (C.). — Die **Schweisstechnische Vers
abteilung** der Deutschen Reichsbahn. (1 300 Wört
Abb.)

1938 **656. (**
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19. Mai, S. 389.
Zusammenarbeit zwischen Eisenbahn und Post i
nemark. (1 300 Wörter.)

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1938 **526 & 62**
Engineer, No. 4293, April 22, p. 438 and No. 4294,
29, p. 464.
DAVID (W. T.). — **Thermodynamics of the p
engine.** (12 000 words & fig.)

1938 **62. (01 & 621**
Engineer, No. 4293, April 22, p. 449.
Non-destructive tests for welds. (1 700 words.)

1938 **625 .1 (06**
Engineer, No. 4293, April 22, p. 450.
American Railway Engineering Association
Annual Meeting). (2 200 words.)

1938 **621 .43**
Engineer, No. 4293, April 22, p. 456.
Articulated railcars for the Great Northern Ra
of Ireland. (1 600 words & fig.)

1938 **6**
Engineer, No. 4293, April 22, p. 457.
Carbide tools. (3 100 words & fig.)

1938 **621**
Engineer, No. 4294, April 29, p. 468.
MACFARLANE (J. W.). — **Welding gener**
(4 300 words & fig.)

8 656 .2

eer, No. 4294, April 29, p. 472.

RTLEY (Sir Harold). — **Amenities of railway** **ıger travel.** (5 400 words.)

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8 625 .212

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lway wheels. (1 200 words.)

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8 624. (.42)

eer, No. 4294, April 29, p. 484.

M. S. Railway and Canal Bridge at Spondon. vords & fig.)

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8 621 .39

ıeer, No. 4294, April 29, p. 485.

tinuous reading power meters. (1 900 words &

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8 621 .8

eer, No. 4294, April 29, p. 480; May 6, p. 516.

'CLAIR (H.). — **Transmission of power by fluid** **ıngs** (Paper presented to the Institution of Me- ˈal Engineers — Abstract and discussion). (8 100 .)

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8 656 .211.7 (.42)

eer, No. 4295, May 6, p. 516.

Southern **Railway motor car ferry « Lyming-** (1 100 words & fig.)

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8 537 .7 & 621 .31

eer, No. 4296, May 13, p. 526.

age regulators. (2 200 words & fig.)

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8 621 .116 & 621 .133.7

eer, No. 4296, May 13, p. 532.

er-water treatment. (500 words.)

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8 669 .1 (06 (.42)

ıer, No. 4296, May 13, p. 540.

Iron and Steel Institute. Symposium on steel ;. (6 300 words.)

621

er, No. 4296, May 13, p. 542.

NALD (G. G.). — **Highest frequency of torsion-** **ation.** (1 400 words & fig.)

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385 .57 (.44) & 385 .58 (.44)

er, No. 4296, May 13, p. 546.

ycho-technical laboratory. (1 300 words & fig.)

621

er, No. 4296, May 13, p. 548.

LIAMS (C. G.) and SPIERS (J.). — **Engine bear-** **ıperatures.** (1 600 words & fig.)

1938 **669 .1**

The Metallurgist, p. 117, Supplt. to The Engineer, April 29.

Grain size of steel. (1 500 words & fig.)

1938 **669**

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The solidification of metals. (1 400 words.)

1938 **669 .1**

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Austenitic chromium-manganese steels. (1 900 words & fig.)

Engineering. (London.)

1938 **625 .13 (.73)**

Engineering, No. 3771, April 22, p. 435.

The Lincoln-vehicular tunnel, New York. (2 800 words & fig.)

1938 **656 .2**

Engineering, No. 3771, April 22, p. 449.

Comfort and the railway passenger. (1 900 words.)

1938 **621 .43**

Engineering, No. 3771, April 22, p. 450.

Diesel-engine progress. (2 400 words.)

1938 **62. (01 & 669 .1**

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HATFIELD (Dr. W. H.). — **Heat-resisting steels.** (3 300 words & fig.)

1938 **621 .7**

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STREET (Dr. A.). — **The application of die casting.** (3 200 words & fig.)

1938 **621 .89**

Engineering, No. 3772, April 29, p. 477.

Addition agents for motor oils. (2 600 words.)

1938 **621 .8**

Engineering, No. 3772, April 29, pp. 481 and 487.

SINCLAIR (H.). — The transmission of power by **fluid couplings** (Paper presented to the Institution of Mechanical Engineers — Abstract and discussion). (10 300 words.)

1938 **624 .51 (.73)**

Engineering, No. 3773, May 6, p. 491.

San Francisco-Oakland Bay Bridge. (3 500 words & fig.)

1938 624 .2
Engineering, No. 3773, May 6, p. 505.
Stresses due to impacts. (2 600 words.)

1938 621 .335
Engineering, No. 3773, May 6, p. 513.
The trend of design of electric locomotives. (3 800 words.)

1938 62. (01
Engineering, No. 3774, May 13, p. 521.
WELTER (G.). — **Corrosion by the impact of falling drops.** (1 300 words & fig.)

1938 621 .89
Engineering, No. 3774, May 13, p. 528.
Refining plant for used lubricating oil. (3 200 words.)

Engineering News-Record. (New York.)

1938 721 .7 (.73)
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Flat slab of tile and concrete. (400 words & fig.)

1938 55 & 721 .1
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NIVEN (W. W.). — **Improved method of soil study.** (1 600 words & fig.)

1938 625 .13 (.73)
Engineering News-Record, No. 14, April 7, p. 539.
JOHNSON (R. S.). — **Railroad bridge built of two 108-ton precast slabs.** (1 300 words & fig.)

1938 624 .63 (.73)
Engineering News-Record, No. 17, April 28, p. 613.
COHEN (A. B.). — **Flood-proof bridge for Binghamton.** (4 500 words & fig.)

1938 624 .2 (.73)
Engineering News-Record, No. 18, May 5, p. 651.
ENGEL (H. J.). — Over 1 000 ft. of continuity (**New eight-span continuous girder bridge.**) (2 200 words & fig.)

1938 621 .392 (.493) & 624 .62 (.493)
Engineering News-Record, No. 18, May 5, p. 654.
Welded bridge failure in Belgium. (900 words & fig.)

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1938 656 .1
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BRUNNER (C. T.). — **Rates agreements** and rates regulation in the road haulage industry. (18 900 words.)

1938 614 .8 &
Journal, Institute of Transport, No. 7, May, p. 276.
HODSOLL (E. J.). — **Defence of transport aga air attack.** (11 200 words.)

Journal, Institution of Civil Engineers. (London.)

1938 621 .31 (.42) & 725 .4 (
Journal, Institution of Civil Engineers, No. 6, A p. 323.
The Galloway hydro-electric development, with cial reference to the constructional works. (20 500 w tables & fig.)

1938 621 .31 (
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The Galloway hydro-electric development, with sp reference to the mechanical and electrical plant. (1 words, tables & fig.)

1938 621 .31 (
Journal, Institution of Civil Engineers, No. 6, A p. 407.
The Galloway hydro-electric development, with sp reference to its interconnexion with the grid. (words & fig.)

1938
Journal, Institution of Civil Engineers, No. 6, A p. 457.
Engineering problems associated with clay, with cial reference to clay slips. (20 000 words & fig.)

1938 625 .13 (
Journal, Institution of Civil Engineers, No. 6, p. 527.
The reconstruction of the Mocoreta and Ti bridges, Argentine North Eastern Railway. (7 500 & fig.)

1938 691 &
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Investigation on the vibration of concrete. words & tables.)

Journal, Institution of Engineers, Austral (Sydney, N. S. W.)

1938 6
Journal, Institution of Engineers, Australia, N March, p. 89.
Producer gas vehicles. (7 300 words & fig.)

1938 62
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BARRACLOUGH (Sir Henry) and GIBSON H. H.). — **The new Dalby straining machine wit racteristic applications.** (9 500 words.)

ıdon & North Eastern Railway Magazine. (London.)

3 **621 .132.8 (.42)**
n & North Eastern Railway Magazine, No. 5, ay, p. 246.
DMAN (C. M.). — **Sentinel Cammel steam rail-** (1 500 words & fig.)

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3 **691. (.42) & 721 .9 (.42)**
n & North Eastern Railway Magazine, No. 5, ay, p. 258.
VLEY (F. L.). — **Central concrete depot, York.** vords & fig.)

Mechanical Engineering. (New York.)

8 **621 .116 & 621 .133.7**
nical Engineering, No. 5, May, p. 371.
RAUB (F. G.) and BRADBURY (T. A.). — **Boiler- treatment.** New methods for preventing em- ment. (4 000 words & fig.)

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8 **614 .7**
nical Engineering, No. 5, May, p. 377.
CKER (R. R.). — **Smoke abatement.** (5 500 .)

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3 **621 .7 & 662**
nical Engineering, No. 5, May, p. 381.
WHINNEY (M. H.). — **Fuels for industrial heat- rnaces.** (3 600 words & fig.)

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3 **621 .43 (43**
nical Engineering, No. 5, May, p. 419.
ct-drive diesel locomotive. (1 000 words & fig.)

Modern Transport. (London.)

3 **656 .2**
n Transport, No. 996, April 16, p. 3 and No. 997, pril 23, p. 9.
RTLEY (Sir Harold). — **Improving the amenities way travel.** Rolling stock design and track ad- nt. (4 700 words and 1 photo.)

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3 **621 .43 & 662**
n Transport, No. 996, April 16, p. 4.
soted sleepers as fuel. (600 words.)

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3 **625 .62 (.42) & 656 .1 (.42)**
n Transport, No. 996, April 16, p. 5.
BAR (C. S.). — Carrying parcels by tram and 2 000 words.)

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3 **656. (.43)**
n Transport, No. 996, April 16, p. 7.
sport in Greater Germany. Probable results of nschluss. (1 900 words.)

1938 **625 .4 (.42)**
Modern Transport, No. 996, April 16, p. 8.
London Transport tube extensions. Progress of new works. (1 400 words.)

1938 **385 .15 (.42)**
Modern Transport, No. 996, April 16, p. 9.
Nationalisation of transport. (2 200 words.)

1938 **623. (.42)**
Modern Transport, No. 996, April 16, p. 12.
Defence against aircraft. (2 100 words.)

1938 **621 .33 (.42)**
Modern Transport, No. 997, April 23, p. 3.
Railway electrification in progress. (2 700 words & fig.)

1938 **625 .1 (.55)**
Modern Transport, No. 998, April 30, p. 5.
Trans-Iranian Railway. (1 800 words & fig.)

1938 **656 .1 & 656 .2**
Modern Transport, No. 998, April 30, p. 7.
Development in road-rail transport. (1 800 words.)

1938 **656. (.66)**
Modern Transport, No. 999, May 7, p. 2.
Interesting experiment in **transport control** (Nigeria). (1 200 words.)

1938 **656**
Modern Transport, No. 999, May 7, p. 3
Transport operators and « big business ». (1 800 words.)

1938 **656 .211.7 (.42)**
Modern Transport, No. 999, May 7, p. 5.
New-type ferry for Southern Railway. (1 400 words & fig.)

1938 **621 .33 (.43)**
Modern Transport, No. 999, May 7, p. 9.
WECHMANN (Prof. Dr.). — **Railway electrification in Germany.** (1 600 words & fig.)

1938 **621 .132.7 (.56)**
Modern Transport, No. 1000, May 14, p. 4.
Industrial locomotives for Turkey. (500 words & fig.)

1938 **656 .21 (.42)**
Modern Transport, No. 1000, May 14, p. 5.
GARDINER (R.). — **Edinburgh as a railway centre.** — Operations at Waverley Station. (3 900 words & fig.)

1938 **621 .132.8 & 621 .8**
Modern Transport, No. 1000, May 14, p. 11.
SINCLAIR (H.). — **Transmission of power by fluid couplings.** — Turbo-mechanical locomotives. (1 900 words & fig.)

1938 **621 .43**

Modern Transport, No. 1000, May 14, p. 12.

Developments in diesel engine design. Rail, road, and air. Progress in 1937. (1 100 words.)

1938 **656 .1 (.42) & 656 .21 (.42)**

Modern Transport, No. 1000, May 14, p. 15.

GUMLEY (Sir Louis S.). — Prospective development at Waverley Station. — **Proposed bus station and car park on station roof.** (1 100 words & fig.)

1938 **656 .254 & 656 .259**

Modern Transport, No. 1000, May 14, p. 17.

Automatic control of trains. (1 000 words & fig.)

1938 **625 .135 (01 & 625 .143.3**

Modern Transport, No. 1000, May 14, p. 26.

Steam locomotives and track wear. — Some inherent difficulties. (1 100 words.)

1938 **385 .1 (.54)**

Modern Transport, No. 1000, May 14, p. 26.

Railway developments in India. — Results of Wedgwood report. (1 100 words.)

1938 **625 .213 (.42)**

Modern Transport, No. 1000, May 14, p. 27.

The historic port of Leith. (2 300 words & fig.)

Proceedings, American Society of Civil Engineers. (New York.)

1938 **621 .31**

Proceedings, American Society of Civil Engineers, No. 4, April, p. 637.

Cost of energy generation. — Second symposium on power costs. A series of 6 papers as hereafter : elements of costs, heat-generated energy, hydro-generated energy, combined energy generation, depreciation and obsolescence, recapitulation. (36 000 words, tables & fig.)

Proceedings, Institution of Mechanical Engineers. (London.)

1937 **536**

Proceedings, Institution of Mechanical Engineers, Vol. 137, November -December, p. 11.

The mechanics of flame and air jets. (20 800 words, tables & fig.)

1937 **621 .6**

Proceedings, Institution of Mechanical Engineers, Vol. 137, November-December, p. 79.

Recent developments in high-speed reciprocating pumps. (15 000 words & fig.)

1937 **621**

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 125.

Diesel traction on railways. (16 000 words, tabl fig.)

1937

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 165.

Friction and heat transmission coefficients. (words, tables & fig.)

1937

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 195.

Heat loss from gilled metal pipes. (4 000 words &

1937 **624 .2 & 625 .14**

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 217.

Impact stresses in a freely supported beam. (1 words & fig.)

1937 **621 .39 & 62**

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 283.

Overhead electric travelling cranes. (7 500 wor fig.)

1937 **626 .**

Proceedings, Institution of Mechanical Engineers, 137, November-December, p. 345.

Modern developments in tractor-drawn exca equipment. (3 300 words & fig.)

Railway Accounts & Finance. (Calcutta.)

1937 **656.**

Railway Accounts & Finance, No. 17, January-M p. 1.

Transport developments in America. (7 900 word

1937

Railway Accounts & Finance, No. 17, January-M p. 15.

Reconciliation of job time and wages with m roll time and wages in railway workshops. (words.)

Railway Age. (New York.)

1938 **621 .135 (01 & 625 .**

Railway Age, April 9, p. 653.

Rail damage and the relation of locomotives the (6 100 words & fig.)

1938 **656 .25 (06**

Railway Age, April 9, p. 669.

Signal Section convenes in Chicago. (Brief abst of economics of stopping and starting trains, cro protection, new standards and descriptions of m apparatus, and discussion.) (4 500 words.)

38 621 .13 (0
vay Age, April 16, p. 695.
NKERD (R. S.). — **Making money with locomo-**. (3 300 words & fig.)

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vay Age, April 16, p. 705.
98 526 717 net income in 1937 of U. S. A. Class I oads. (200 words & tables.)

38 725 .31 (.73)
vay Age, April 16, p. 708.
ilds inexpensive station of unusual design. (800 s & fig.)

38 625 .1 (.73) & 721 .1 (.73)
vay Age, April 23, p. 728.
wer construction affects tracks on three levels.) words & fig.)

38 621 .335 & 621 .43
vay Age, April 23, p. 737.
ctric locomotive changed to diesel electric. (800 s & fig.)

38 621 .132.3 (.73) & 621 .132.5 (.73)
vay Age, April 30, p. 761.
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8 656 .21
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on Pacific improves station at Cheyenne, Wyom- 1 100 words & fig.)

8 656 .225 (.73)
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8 621 .13 (0
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KERMAN (W. C.). — **Possibilities of the mo-steam locomotive.** (6 400 words & fig.)

8 656 .211.5
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ay Age, May 7, p. 807.
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1938 **625 .13 (.73)**
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Meeting the test at a bridge burn-out. (2 800 words & fig.)

1938 **625 .1 (01 (.73)**
Railway Engineering and Maintenance, May, p. 319.
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KNOWLES (C. R.). — **A water station without pump house or pumper.** (900 words & fig.)

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ARTHURTON (A. W.). — **Further impressions of overseas transport.** (900 words.)

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Automatic train control on the G. W. R. (800 words & fig.)

1938 **385. (091 (.52)**
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The Japanese Government Railways. (600 words.)

1938 **621 .8 & 621 .9**
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Variable speed gear for railway shop machinery. (700 words & fig.)

1938 **656 .256.3 (.44)**
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1938 **625 .23 (0**
Railway Gazette. No. 16. April 22, p. 802.
Aluminium in rolling stock. (1 100 words & fig.)

1938 **621 .139 (.42)**
Railway Gazette, No. 16, April 22, p. 805.
Storing tools and materials in locomotive shops. (500 words & fig.)

1938 **625 .4 (.42)**
Railway Gazette, No. 16, April 22, p. 812.
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1938 **385 .113 (.82)**
Railway Gazette, No. 17, April 29, p. 831.
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1938 **624. (.489) & 656 .211.7 (.489)**
Railway Gazette, No. 17, April 29, p. 832.
Ferries and bridges in Denmark. (1 400 words & 1 map.)

1938 656 .253 (.42)
Railway Gazette, No. 17, April 29, p. 835.
Colour-light signalling on the Chingford branch, L. N. E. R. (1 900 words & fig.)

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Replacing wooden by steel coach bodies in France. (600 words & fig.)

1938 621 .94 (.42)
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Machining locomotive piston valve liners. (400 words & fig.)

1938 625 .3 (.67)
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Ministry of Transport accident report. (1 700 words.)

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BULKELEY (G. V. O.). — Some considerations affecting **average speed** on Crown Colony Railways. (1 700 words.)

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A new level crossing indicator. (600 words & fig.)

1938 385. (01 & 656
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Notes on a unified colonial railway service. (1 900 words.)

1938 656 .211 (.42)
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New stations at Surbiton and Richmond, Southern Railway. (3 000 words & fig.)

1938 625 .142.1 (.73) & 656 .281 (.73)
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Derailment on American concrete track. (600 words & fig.)

1938 621 .3
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Gazette, April 29.
Electric locomotive design. (4 800 words & fig.)

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Gazette, April 29.
Glass-bulb rectifier substation in India. (1 900 wo
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Stainless steel trains in Italy. (1 000 words.)

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Gazette, May 13.
Large diesel locomotives. (1 200 words.)

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A recent English railway oil-engine model. (1
words & fig.)

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Gazette, May 13.
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transmission devices incorporated.** (800 words & fig.

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WEBER (E. F.). — **The Burlington Zephyrs.** (4
words & fig.)

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A high power electro-magnetic gearbox. (500 wo
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Heavy diesel-electric shunting locomotive operat
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The May timetables (Great Britain). (1 800 words

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ALLEN (C. J.). — **British locomotive practice
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LE (H.). — **The main line train services of the & South Eastern Railway.** (3 600 words & fig.)

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D (B.). — **Railcars** on the Great Northern Rail-700 words & fig.)

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4 **freight locomotives.** (4 200 words & fig.)

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ETZ (A. I.). — Simplified formulas for calculat-e **air resistance of trains.** (4 000 words, tables &

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ware & Hudson builds lightweight **welded freight** 2 100 words, tables & fig.)

621 .133.1
y Mechanical Engineer, No. 4, April, p. 138.
es and remedies of **slagging and honey combing.** words.)

Railway Signaling. (Chicago.)

656 .257 (.73)
y Signaling, April, p. 207.
more & Ohio C. T. installs **route interlocking.** words & fig.)

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656 .25 (06 (.73)
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1938 625 .162 (.73) & 659 .259 (.73)
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Railway Signaling, May, p. 283.
Four interlockings combined. (4 700 words & fig.)

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Remote control on the Denver & Rio Grande Western. (1 500 words & fig.)

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Railway Signaling, May, p. 292.
Remote control on the Michigan Central. (1 900 words & fig.)

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Carrier telephones on the Berlington. (1 000 words & fig.)

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C. T. C. replaces staff system on the Milwaukee. (1 700 words & fig.)

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1938 385. (091 (.43)
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WOLFGANG MEJER (Dr.). — **The largest transportation concern in the world.** (2 000 words & fig.)

1938 625 .245 (.68)
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Long wagons for the conveyance of 60-foot rails, etc. (400 words.)

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Research work. (1 100 words.)

The Locomotive. (London.)

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2-6-2 mixed traffic locomotive, L. N. E. R. (1 200 words.)

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Institution of Locomotive Engineers. — **Long distance electrification on the German State Railways.** (1 000 words.)

1938 **621 .133.8**
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Hydraulic window wiper for locomotives. (500 words.)

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Three-car oil-engined train L. M. S. R. (2 700 words & fig.)

1938 **621 .335 (.42)**
The Locomotive, No. 549, May 14, p. 149.
Battery locomotives for new works and maintenance. (1 100 words & fig.)

1938 **621 .43**
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Diesel-mechanical shunting locomotives. (2 200 words & fig.)

1938 **625 .245 (.42)**
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Wagons for conveyance of edible oils, L. M. S. R. (2 500 words & fig.)

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1938 **621 .43 (.44)**
The Oil Engine, No. 61, Mid May, p. 4.
A 4 000 h. p. French diesel locomotive. (2 100 words & fig.)

1938 **662**
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Alternative fuels for road vehicles. — **The possibilities of vegetable oils.** (900 words.)

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TUPLIN (W. A.). — **Gear drives for diesel-engine camshafts.** (3 000 words & fig.)

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The Oil Engine, No. 61, Mid May, p. 16.
SINCLAIR (H.). — **Power transmission by fluid coupling.** (2 500 words & fig.)

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The Oil Engine, No. 61, Mid May, p. 26.
Atchinson, Topeka and Santa Fe's **six new diesel locomotives.** (1 000 words & fig.)

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1938 **659. (**
Transit Journal, No. 4, April, p. 121.
OLCOTT (H. W.). — **Why transit advertisi**
Today's problem is not how to furnish good service,
how to get the public to buy it. (2 800 words.)

1938 **388. (**
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HARTMAN (W.). — Cutting cost of window clea
after painting. (300 words.)

In Spanish.

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ERPS (F. R.) & GOODGINS (A. L.). — Distribu
de las cargas de las ruedas y proyecto de losas de
zadas de **puentes de hormigón armado.** (8 800 palal
24 cuadros & fig.)

1938 **62. (01 &**
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TELLER (L. W.) & BUCHANAN (J. A.). —
maquina para someter el **hormigón** a ensayos de
pacto y de cargas prolongadas. (10 000 palabras &

In Italian.

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CHEMELLO (G.). — **Sulla stabilita trasversale**
lastre. (3 700 parole & fig.)

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1938 **625 .19 (**
La tecnica professionale, aprile, p. 73.
L'alluvione intorno a Roma del dicembre 1937. (
parole & fig.)

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SPANI (D. F.). — Le proprietà di talune **leghe**
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1938 **621 .335 (.45) & 621 .43 (**
La tecnica professionale, aprile, p. 87.
VANNI e FASSI. — Alcuni particolari costru
dell' **elettrotreno italiano** e dell' **automotrice te**
messi a confronto. (1 400 parole & fig.)

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TELUCCI. — Sul corretto uso del **freno continuo.** parole.)

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tecnica delle ferrovie ital., 15 aprile, p. 171.
EMONTI (G.). — **Nuove carrozze a cassa metal-** **3Cz** costruite dalle Ferrovie Italiane dello Stato ervizi internazionali. (1 600 parole & fig.)

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625 .172

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NNICI (A.). — **L'apparecchio portatile Hallade** **tore** dei difetti del binario. (9 300 parole & fig.)

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tecnica delle ferrovie ital., 15 aprile, p. 219.
OCCHI (U.). — Sulle **distribuzioni a cassetto** **cessione lineare** all' introduzione costante. (5 400 & fig.)

In Dutch.

De Ingenieur. (Den Haag.)

621 & 721 .9

enieur, Nr 18, 6 Mei, p. Bt. 33.
UMACHER (P.). — Baustahlgewebe im **Eisen-** **u.** (3 000 woorden, 2 tafereelen & fig.)

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S (A.). — Beschouwingen over het **Albertkanaal.** woorden & fig.)

Spoor- en Tramwegen. (Utrecht.)

385 .4 (.44)

n Tramwegen, Nr 9, 26 April, p. 197.
SETTEN (D.). — **Reorganisatie** der Fransche gen. (5 000 woorden.)

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n Tramwegen, Nr. 9, 26 April, p. 202; Nr. 10, Iei, p. 231.
ANG (W.). — Het **weerstands- en automatisch** bij de Deli Spoorweg-Maatschappij. (2 200 & fig.)

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LESSEN (J.). — De **electrificatie** van het mid- er Nederlandschen Spoorwegen. (1 900 woor- g.)

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1938 — **656** .211 (.44) = **91** .885

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GROBICKI (W.) & SOBOLEWSKI (J.). — **The Paris passenger stations and their working methods.** (6 000 words & fig.)

1938 — **621** .142.3 (.438) = **91** .885

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ZAGORSKI (S.). — **Metal sleepers** and their use on the Polish State Railways. (3 000 words & fig.)

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LANGROD (A.). — **Rolling stock** considered from the Polish State Railways' point of view, and the possibility of building it in Poland. (7 300 words.)

In Portuguese.

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1938 — 385 .1

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SOUZA (F. de). — O **problema nacional ferroviario.** (3 300 palavras & fig.)

In Rumanian.

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PALTOV (Al.). — **The cost of carriage by railway.** (2 300 words, tables & fig.)

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PETRESCU (S.). — An investigation into **locomotive lubrication.** (12 800 words & fig.)

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DRAGANESCU (St.) & FILITTI (A.). — The **psychotechnical services** of the Rumanian Railways. (5 300 words & fig.)

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ZANESCU (A.) & DEREVICI (A.). — **The railc of the Rumanian Railways.** (16 300 words & fig.)

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1938 — 621 .5 & 621 .6
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1938 — 621 .4
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1938 536 & 621 .116
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1938 656 .211.7 (.42)
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(= 91.885)

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Superimposing in power stations. (2 900 words.)

1938 62. (01
The Metallurgist, p. 129, Suppl. to the Engineer, June 24.
Magnetic methods of testing materials. (2 400 words & fig.)

1938 62. (01 & 669 .1
The Metallurgist, p. 131, Suppl. to the Engineer, June 24.
Cracking of steel in ammonium nitrate solutions. (1 200 words.)

1938 62. (01 & 669 .1
The Metallurgist, p. 132, Suppl. to the Engineer, June 24.
The rate of corrosion of copper-bearing steels in the atmosphere. (1 900 words & fig.)

1938 62. (01
The Metallurgist, p. 135, Suppl. to the Engineer, June 24.
Measurement of surface stress by X-rays. (3 500 words & fig.)

1938 669 .1
The Metallurgist, p. 138, Suppl. to the Engineer, June 24.
The effect of superheating molten steel. (2 300 words.)

1938 669
The Metallurgist, p. 140, Suppl. to the Engineer, June 24.
Heat of formation of alloys. (1 400 words & fig.)

Engineering. (London.)

1938 621 .392 & 624. (0
Engineering, No. 3779, June 17, p. 669.
BONDY (O.). — **Collapse of an all-welded bridge at** Hasselt, Belgium. (2 800 words & fig.)

1938 621 .133 (01
Engineering, No. 3779, June 17, p. 671.
FRY (L. H.). — **Heat balances for locomotive boilers.** (5 300 words.)

1938 621 .43 (.82)
Engineering, No. 3779, June 17, p. 673.
100-H.P. railcars with mechanical transmission for South American Railways. (3 200 words & fig.)

1938 621 .93 (.42)
Engineering, No. 3779, June 17, p. 691.
Metal-cutting saws. (1 100 words.)

1938 62. (01 & 669 .1
Engineering, No. 3779, June 17, p. 692.
HARRISON (R.). — **The effect of copper on some alloy steels.** (6 000 words, tables & fig.)

1938 624 .51 (.73)
Engineering, No. 3780, June 24, p. 697.
San Francisco-Oakland Bay bridge. (5 100 words & fig.)

1938 62. (01
Engineering, No. 3780, June 24, p. 718.
Apparatus for testing piston rings. (900 words & fig.)

1938 621 .
Engineering, No. 3780, June 24, p. 722.
DOWSON (R.). — **The effect of circumferential p of steam turbine blades on torque.** (4 000 words, ta & fig.)

1938 66
Engineering, No. 3780, June 24, p. 724.
BACON (N. H.). — **Casting-pit practice in o hearth melting shops.** (1 700 words.)

1938
Engineering, No. 3781, July 1, p. 1 and No. 3782, Jul p. 34.
JUZA (Dr. J.). — **Equation of state for steam.** (words, tables & fig.)

1938 532. (.
Engineering, No. 3781, July 1, p. 3.
The hydraulic laboratory of the Federal Institut Technology, Zurich. (3 600 words & fig.)

1938 621 .43 (
Engineering, No. 3781, July 1, p. 10.
The Peter super-scavenge diesel engine. (1 900 w & fig.)

1938 656 .283 (
Engineering, No. 3781, July 1, p. 16.
The Castlecary railway accident. (2 000 words.)

1938 621 .33 (
Engineering, No. 3781, July 1, p. 20.
Southern Railway electrification to Portsmouth Horsham. (1 000 words.)

1938 62
Engineering, No. 3781, July 1, p. 20.
The prevention of eye injuries in industry. words.)

1938 62
Engineering, No. 3781, July 1, p. 21.
LUGT (G. J.) and VISSER (N. J.). — **Whirl of engine crankshafts.** (3 800 words & fig.)

1938 6
Engineering, No. 3781, July 1, p. 24.
GEARY (W.). — **Hot-metal practice in fixed hearth furnaces.** (2 800 words.)

1938 625 .232
Engineering, No. 3782, July 8, p. 41.
New « Flying Scotsman » trains for the Londo North Eastern Railway. (1 500 words.)

1938 621 .335 (.82) & 621 .43
Engineering, No. 3782, July 8, p. 48.
Diesel-electric locomotives for the Buenos Ayres Southern Railway. (1 000 words.)

016

ing, No. 3782, July 8, p. 50.

ternational Federation for Documentation. (900

621 .338 (.42)

ing, No. 3782, July 8, p. 51.

olling stock for the London Underground Rail-
300 words.)

621 .31 (.73)

ing, No. 3783, July 15, p. 59.

wer house at Boulder Dam. (1 500 words & fig.)

621

ing, No. 3783, July 15, p. 69.

DALE (C. V.). — The measurement of mecha-
wer. (1 900 words & fig.)

625 .4 (.42) & 656 .284 (.42)

ing, No. 3783, July 15, p. 71.

Vaterloo Tube Railway accident. (800 words.)

62. (01 & 721 .1

ing, No. 3783, July 15, p. 87.

s in reinforced-concrete piles during driving.
ords.)

gineering News-Record. (New York.)

721 .1 (.73)

ing News-Record, No. 24, June 16, p. 850.

IL (R. M.). — Compacting cohesionless mate-
00 words & fig.)

62. (01 & 694

ing News-Record, No. 24, June 16, p. 855.

AMS (H. A.). — Laboratory tests on structural
(3 300 words.)

721 .1 (.73)

ing News-Record, No. 26, June 30, p. 897.

I (L. F.). — Controlled caisson sinking. (1 600
fig.)

624 .52 (.73)

ng News-Record, No. 26, June 30, p. 901.

(H. J.). — Multiple Cantilever completed at
500 words & fig.)

627 .82 (.73)

ng News-Record, No. 1, July 7, p. 13.

t multiple arch dam. (4 300 words & fig.)

Journal, Institute of Transport. (London.)

1938 **347 .763 (.4) & 656. (.4)**

Journal, Institute of Transport, No. 9, July, p. 343.

HENDERSON (A.). — **The regulation and control of transport in Europa.** (17 200 words.)

1938 **656 .1 & 656 .23**

Journal, Institute of Transport, No. 9, July, p. 359.

MILLS (G.). — **The price of transport.** (18 800 words.)

1938 **347 & 351**

Journal, Institute of Transport, No. 9, July, p. 376.

GRAY (A.). — **The conception of public utility in relation to transport.** (16 000 words.)

Journal, Institution of Engineers, Australia. (Sydney, N. S. W.)

1938 **62 & 69**

Journal, Institution of Engineers, Australia, No. 5, May, p. 165.

CHAPMAN (Sir Robert). — **The growth of the use of the scientific method in structural design.** (12 500 words & fig.)

1938 **625 .122 (.94)**

Journal, Institution of Engineers, Australia, No. 5, May, p. 176.

POOLE (G. G.). — **Flood protection levees.** (6 400 words & fig.)

Locomotive, Firemen and Enginemen's Magazine. (Cleveland, Ohio.)

1938 **385 .517 (.73)**

Locomotive, Firemen and Enginemen's Magazine, No. 1, July, p. 15.

Congress enacts railroad unemployment insurance law. (4 400 words.)

London & North Eastern Railway Magazine. (London.)

1938 **621 .132.8 (.42)**

London & North Eastern Railway Magazine, No. 7, July, p. 380.

STEDMAN (C. M.). — **Sentinel Cammell steam railcars.** (700 words & fig.)

1938 **621 .13 (0**

London & North Eastern Railway Magazine, No. 7, July, p. 390.

The « cab » of a modern locomotive. (300 words & fig.)

Mechanical Engineering. (New York.)

1938 **669 .1**

Mechanical Engineering, No. 7, July, p. 535.

SEEMANN (A. K.). — **Oxyacetylene surface hardening.** (4 400 words & fig.)

1938 01
Mechanical Engineering, No. 7, July, p. 550.
CRAVER (H. W.). — The role of the engineering library. (3 700 words & fig.)

Modern Transport. (London.)

1938 656. (.44)
Modern Transport, No. 1005, June 18, p. 3.
Industrial transport in France. (2 400 words.)

1938 625 .235 (.44)
Modern Transport, No. 1005, June 18, p. 4.
Metallised railway coaches. Increasing the safety factor. (500 words & fig.)

1938 656 .225 (.44) & 656 .261 (.44)
Modern Transport, No. 1005, June 18, p. 5.
Facilitating container transport. Most adaptable to horse haulage. (2 500 words & fig.)

1938 656 (06 (.42)
Modern Transport, No. 1005, June 18, p. 9.
Transport Congress at Folkestone. (1 800 words & fig.)

1938 656 .283 (.42)
Modern Transport, No. 1006, June 25, p. 3.
Steel and wood in rolling stock construction. Modern signalling and automatic train control. Chief Inspecting Officer's report on Castlecary disaster. (4 000 words.)

1938 385 .1 (.42)
Modern Transport, No. 1006, June 25, p. 7.
DAVIES (A.). — Railways and industrial development. Local requirements and national policy. (2 200 words.)

1938 656
Modern Transport, No. 1006, June 25, p. 8.
SMITH (F.). — Future of ancillary transport. Relationship to national systems. (1 700 words.)

1938 347 .763 (.42) & 656 .1 (.42)
Modern Transport, No. 1006, June 25, p. 9.
HICKMOTT (H. E.). — Road passenger transport and its functions. Effects of legislative action. (1 900 words.)

1938 385 .3 (.42) & 656. (.42)
Modern Transport, No. 1006, June 25, p. 15.
Transport and the State. Discussion on control and ownership. An interesting broadcast. (2 100 words.)

1938 385 .587 (.42) & 625 .26 (.42)
Modern Transport, No. 1007, July 2, p. 3.
Mass production on the L. M. S. R. The job analysis system. (3 700 words.)

1938 621 .33 (.4
Modern Transport, No. 1007, July 2, p. 5, No. 10
July 9, p. 7 and No. 1009, July 16, p. 9.
Southern Railway electrification in West Suss
(7 000 words & fig.)

1938 621 .43 (.4
Modern Transport, No. 1007, July 2, p. 6.
Development in diesel engine design. Uni-directio
scavenging. (1 100 words & fig.)

1938 656 .1 (.4
Modern Transport, No. 1007, July 2, p. 7.
Goods road transport in Lancashire. Trader's ne
and obligations. (1 900 words.)

1938 621 .338 (.4
Modern Transport, No. 1007, July 2, p. 10.
New tube trains for London Transport. (4 200 wo
& fig.)

1938 625 .232 (.4
Modern Transport, No. 1007, July 2, p. 15.
New trains for Flying Scotsman service. Novel id
in furnishing and ventilation. (800 words & fig.)

1938 625 .232 (.4
Modern Transport, No. 1008, July 9, p. 3.
New trains for Flying Scotsman services. (2 600 wo
& fig.)

1938 621 .43 (.8
Modern Transport, No. 1009, July 16, p. 4.
Oil-electric locomotives for Argentina. (1 000 words
fig.)

1938 621 .132.3 (.4
Modern Transport, No. 1009, July 16, p. 5.
New locomotives for L. M. S. express services. N
streamlined Pacific type units. (900 words & fig.)

1938 621 .132.3 (.4
Modern Transport, No. 1009, July 16, p. 10.
L. N. E. R. locomotive rebuilt. Conversion of fo
cylinder Atlantic type. (500 words & fig.)

1938 621 .3
Modern Transport, No. 1009, July 16, p. 11.
Welding steel to cast iron. (500 words & fig.)

New Zealand Railways Magazine. (Wellington

1938 385. (09 (.9
New Zealand Railways Magazine, No. 2, May, p. 2
NEALE (E. P.). — The Heyday of railway constr
tion. (2 800 words & fig.) (To be contiuued.)

Proceedings, American Society of Civil Engineers. (New York.)

938 625 .143.4
c., Americ. Soc. Civil Eng., No. 6, June, p. 1167.
. **new theory of rail expansion.** (4 100 words & fig.)

938 385 .2
c., Americ. Soc. Civil Eng., No. 6, June, p. 1187.
Vater transportation versus rail transportation. 00 words.)

938 624 .5
c., Americ. Soc. Civil Eng., No. 6, June, p. 1222.
reliminary design of suspension bridges. (1 500 rds.)

Railway Age. (New York.)

938 621 .43 (.73)
lway Age, No. 24, June 11, p. 970.
Iissouri & Arkansas rail cars. (2 100 words & fig.)

938 625 .1 (.73)
lway Age, No. 24, June 11, p. 972.
outhern Pacific to build 30-mile line diversion. (1 100 rds & 1 map.)

938 656 .212.9 (.73) & 656 .225 (.73)
lway Age, No. 24, June 11, p. 975.
OWE (A. A.). — **Terminal Vs. main-line operation.** 00 words.)

938 625 .143.4 (.73)
lway Age, No. 26, June 25, p. 1042.
ALBOT (A. N.). — **Finding the answer to the rail t problem.** (Extensive instrument and service tests ig conducted by the A. R. E. A. promise to disclose lamental information.) (4 000 words & fig.)

938 621 .132.3 (.72)
lway Age, No. 26, June 25, p. 1048.
igh-capacity passenger power for Southern Pacific. reamline locomotives of the 4-8-4 type.) (1 700 ds.)

938 656 .284 (.73)
way Age, No. 26, June 25, p. 1050.
hirty-eight lives lost when cloudburst damages ge. (2 000 words & fig.)

938 625 .246 (.73)
way Age, No. 26, June 25, p. 1053.
TUEBING (A. F.). — **High-tensile steels** demon- te durability as car material. (2 400 words.)

38 656 .1 (.73)
way Age, No. 26, June 25, p. 1055.
rving the Rio Grande Valley (Missouri Pacific bus idiary gives modern transportation, to Southern tip 'exas.) (1 300 words.)

1938 656 .225 (.73) & 656 .1 (.73)
Railway Age, No. 1, July 2, p. 4.
What the shipper wants. (A symposium of views of industrial traffic managers in varied industries as to possibilities for service improvements.) (4 000 words.)

1938 625 .142 (.73) & 625 .173 (.73)
Railway Age, No. 1, July 2, p. 8.
Story of **tie renewals** in 1937. (1 700 words.)

1938 625 .243 (.73)
Railway Age, No. 1, July 2, p. 14.
Bangor & Aroostook orders 500 **box cars** for Newsprint Lading. (1 300 words & fig.)

1938 625 .232 (.73) & 656 .224 (.73)
Railway Age, No. 2, July 9, p. 35.
100 years of **rail mail service.** (3 200 words & fig.)

1938 62. (01 (06 (.73)
Railway Age, No. 2, July 9, p. 39.
Materials testing group meets at Atlantic City. (2 800 words.)

1938 621 .132.8 (.73)
Railway Age, No. 2, July 9, p. 42.
Ten **articulated locomotives** for the Denver & Rio Grande Western. (2 400 words & fig.)

1938 621 .13 (06 (.73) & 625 .2 (06 (.73)
Railway Age, No. 2, July 9, p. 45.
Mechanical division reports presented at General Committee Meeting. (27 000 words.)

1938 625 .232 (.73)
Railway Age, No. 2, July 9, p. 68.
Lightweight « de luxe » coaches for the New York Central. (1 500 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

1938 625 .141 (.73)
Railway Engineering and Maintenance, July, p. 421.
MILLER (A. A.). — **Sub-ballast slabs cure unstable roadbed.** (2 700 words & fig.)

1938 656 .284 (.73)
Railway Engineering and Maintenance, July, p. 423.
Cloudburst undermines bridge in Montana — 47 lives lost. (400 words & fig.)

1938 624 .1 (.73) & 625 .123 (.73)
Railway Engineering and Maintenance, July, p. 424.
Drainage system solves serious **bridge filling problem.** (2 100 words & fig.)

1938 385 .517.7 (.73) & 625 .232 (.73)
Railway Engineering and Maintenance, July, p. 427.
Milwaukee provides **all-steel camp cars.** (1 800 words & fig.)

1938 **621** .43 (.73)
Railway Engineering and Maintenance, July, p. 431.
Analysis of crawler units on Chesapeake & Ohio emphasizes effect of use factor on unit costs. (1 700 words & fig.)

1938 **621** .392 (.73) & **625** .173 (.73)
Railway Engineering and Maintenance, July, p. 433.
Automobile truck for welding frogs and crossings. (800 words & fig.)

Railway Gazette. (London.)

1938 **621** .135.2 & **625** .214
Railway Gazette, No. 24, June 17, p. 1159.
Asbestos wearing surfaces for locomotives and rolling stock. (1 100 words & fig.)

1938 **621** .392 (.54) & **721** .5 (.54)
Railway Gazette, No. 24, June 17, p. 1160.
Arc welding in Indian station roofing. (1 000 words & fig.)

1938 **625** .23 (.51)
Railway Gazette, No. 24, June 17, p. 1161.
New steel passenger coaches for China. (2 800 words & fig.)

1938 **656** .257 (.44)
Railway Gazette, No. 24, June 17, p. 1169.
Signalling at the gare de Lyon, Paris. (2 800 words & fig.)

1938 **621** .132.8
Railway Gazette, No. 25, June 24, p. 1199.
REIDINGER (A.). — **An exhaust turbine locomotive.** (800 words & fig.)

1938 **621** .392 (.62) & **625** .13 (.62)
Railway Gazette, No. 25, June 24, p. 1201.
Bridge strengthening by welding in the Sudan. (700 words & fig.)

1938 **621** .132.3 (.42)
Railway Gazette, No. 25, June 24, p. 1203.
New non-streamlined 4-6-2 type express locomotive, L. M. S. R. (300 words & fig.)

1938 **656** .284 (.42)
Railway Gazette, No. 25, June 24, p. 1207.
Ministry of Transport accident report. Castlecary, L. N. E. R., December 10, 1937. (5 700 words & fig.)

1938 **656.** (.44)
Railway Gazette, No. 1, July 1, p. 14.
Rail and road on the Riviera. (900 words.)

1938 **347** .763 (.42) & **656** .1 (.42)
Railway Gazette, No. 1, July 1, p. 15.
Third **annual report of the Licensing Authorities.** (1 300 words.)

1938 **656** .1 (.42)
Railway Gazette, No. 1, July 1, p. 16.
Rear-engined buses for London Transport. (1 600 words & fig.)

1938 **656** .212.6 (.43) & **656** .225 (.43)
Railway Gazette, No. 1, July 1, p. 19.
Container handling in Germany. (600 words & fig.)

1938 **656** .253 (.42)
Railway Gazette, No. 1, July 1, p. 23.
Resignalling of Paragon Station, Hull, L. N. E. R. (2 100 words & fig.)

1938 **625** .232 (.42)
Railway Gazette, No. 1, July 1, p. 27.
New buffet cars, Southern Railway. (4 figures.)

1938 **621** .338 (.42)
Railway Gazette, No. 1, July 1, p. 29.
New tube rolling stock. (2 100 words & fig.)

1938 **656** .222.5 (.43)
Railway Gazette, No. 2, July 8, p. 57.
Railway communication between Berlin and Vienna. A brief survey of the development of important trunk routes and their relationship to political changes. (1 100 words.)

1938 **621** .132.6 (.42)
Railway Gazette, No. 2, July 8, p. 58.
New 0-6-2 type tank locomotive for the War Department. (1 100 words & fig.)

1938 **656** .213 (.51)
Railway Gazette, No. 2, July 8, p. 63.
Large coal-handling plant Lung-Hai Railway, China. (400 words & fig.)

1938 **625** .232 (.42)
Railway Gazette, No. 2, July 8, p. 64.
New Flying Scotsman trains, L. N. E. R. (2 200 words & fig.)

1938 **656** .222.1 (.42)
Railway Gazette, No. 2, July 8, p. 77.
The Flying Scotsman trains of 1888 and 1938. (1 700 words & fig.)

1938 **656** .222.1 (.42)
Railway Gazette, No. 2, July 8, p. 78.
A new L. N. E. R. speed record. (700 words & fig.)

1938 **385** .15 (.71)
Railway Gazette, No. 3, July 15, p. 115.
The Canadian Railways : unification or co-operation. (4 000 words & 1 map.)

1938 **62.** (0
Railway Gazette, No. 3, July 15, p. 118.
Amsler planimeter. (300 words.)

1938 385. (01 (.6
Railway Gazette, No. 3, July 15, p. 119.
An unified Colonial Railway service. (1 500 words.)

1938 624 .32 (.489)
Railway Gazette, No. 3, July 15, p. 120.
New Limfjord bridge, Danish State Railways. (900 words & fig.)

1938 621 .133 (.44)
Railway Gazette, No. 3, July 15, p. 123.
A remarkable **boiler explosion** in France. (1 900 words & fig.)

1938 621 .132.8 (.67)
Railway Gazette, No. 3, July 15, p. 127.
Beyer-Garratt locomotives for the Rhodesia Railways. (900 words & fig.)

1938 621 .132.3 (.42)
Railway Gazette, No. 3, July 15, p. 129.
Converted Ivatt Atlantic locomotive, L. N. E. R. (400 words & fig.)

1938 621 .43 & 621 .8
Diesel Railway Traction, p. 90, Supplt. to the Railway Gazette, July 8.
The transmission of power, some of the features of drives through fluid couplings. (1 600 words & fig.)

1938 656 .252 (.42 + .44)
Diesel Railway Traction, p. 91, Supplt. to the Railway Gazette, July 8.
Audible warnings for railcars. — Compressed air whistles in British and French practice. (700 words.)

1938 621 .43 (.931)
Diesel Railway Traction, p. 92, Supplt. to the Railway Gazette, July 8.
New Zealand activity. (200 words & fig.)

1938 621 .43 (.437)
Diesel Railway Traction, p. 93, Supplt. to the Railway Gazette, July 8.
HARCAVI (G.). — **Thirteen years of diesel traction** in Czechoslovakia. (2 300 words & fig.)

1938 621 .43 (.61)
Diesel Railway Traction, p. 96, Supplt. to the Railway Gazette, July 8.
Articulated trains for North Africa. (600 words & fig.)

1938 621 .335 (.82) & 621 .43 (.82)
Diesel Railway Traction, p. 97, supplt. to the Railway Gazette, July 8.
Main line locomotives for Argentina. (500 words & fig.)

1938 621 .335 (.44) & 621 .43 (.44)
Diesel Railway Traction, p. 98, Supplt. to the Railway Gazette, July 8.
Express diesel-electric locomotives in France. (3 200 words & fig.)

1938 621 .43 (.42)
Diesel Railway Traction, p. 103, Supplt. to the Railway Gazette, July 8.
A gear-driven pressure charger. (900 words & fig.)

1938 621 .33 (.42)
Electric Railway Traction, p. 1221, Supptl. to the Railway Gazette, June 24.
Mid-Sussex and Sussex Coast electrification, Southern Railway. (Traffic operation, signalling arrangements, civil engineering works, power supply and distribution, rolling stock.) (7 700 words & fig.)

Railway Magazine. (London.)

1938 624 .62 (.66)
Railway Magazine, No. 493, July, p. 1.
PEIRSON (J. B.). — **The Victoria Falls bridge.** (900 words & fig.)

1938 656 .222.1 (.44)
Railway Magazine, No. 493, July, p. 5.
Recent french locomotive performance. I. — Eastern region. (2 600 words & fig.)

1938 656 .222.1 (.42)
Railway Magazine, No. 493, July, p. 12.
ALLEN (C. J.). — **British locomotive practice and performance.** (5 700 words & fig.)

1938 625 .1 (.42)
Railway Magazine, No. 493, July, p. 25.
New Southern Railway suburban line. (400 words & fig.)

1938 385. (093 (.73)
Railway Magazine, No. 493, July, p. 35.
LEE (Ch. E.). — **The birth of railways in the U. S. A.** (3 200 words & fig.)

Railway Signaling. (Chicago.)

1938 656 .256.3 (.73)
Railway Signaling, July, p. 391.
Rock Island installs 467 miles of **automatic blocks.** (4 400 words & fig.)

1938 656 .255 (.73)
Railway Signaling, July, p. 398.
Signaling and spring switches on Southern. (4 000 words & fig.)

1938 656 .25 (06 (.73)
Railway Signaling, July, p. 403.
Superintendents discuss **signaling.** (1 800 words & fig.)

1938 656 .253 (.73)
Railway Signaling, July, p. 405.
Electric semaphore lamps on the Chicago Great Western. (1 600 words & fig.)

1938 656 .28 (01 (.73)
Railway Signaling, July, p. 408.
Highway crossing accidents. (700 words.)

1938 625 .162 (.73) & 656 .259 (.73)
Railway Signaling, July, p. 409.
Semi-automatic gates on the Milwaukee. (1 700 words & fig.)

The Locomotive. (London.)

1938 625 .232 (.42) & 656 .222.1 (.42)
The Locomotive, No. 551, July 15, p. 200.
The Flying Scotsman of 1888 and 1938. (2 800 words & fig.)

1938 621 .338 (.42)
The Locomotive, No. 551, July 15, p. 208.
Electric stock, Bognor and Littlehampton Lines, Southern Railway. (1 900 words & fig.)

1938 656 .222.1 (.42)
The Locomotive, No. 551, July 15, p. 210.
125 m. p. h. on the L. N. E. R. (500 words.)

1938 621 .338 (.42)
The Locomotive, No. 551, July 15, p. 211.
New tube trains, L. P. T. B. (900 words.)

1938 621 .13 (02
The Locomotive, No 551, July 15, p. 212.
PHILLIPSON (E. A.). — **The steam locomotive in traffic.** (2 200 words & fig.)

1938 621 .133.8
The Locomotive, No. 551, July 15, p. 216.
A new speed indicator and recorder. (500 words.)

1938 625 .2 (0
The Locomotive, No. 551, July 15, p. 221.
SANDERS (L. I.). — **Carriage and wagon design and construction.** (4 500 words.)

1938 621 .132.1 (.42)
The Locomotive, No. 551, July 15. p. 229.
MORRIS (O. J.). — **Standardising Southern Railway Locomotives,** Central Section. (2 800 words & fig.)

The Oil Engine. (London.)

1938 621 .43
The Oil Engine, No. 63, Mid July, p. 68.
A year's development in **diesel rail traction.** (2 300 words & fig.)

1938 625 .215 (.85)
The Oil Engine, No. 63, Mid July, p. 71.
A novel bogie for steam railcar conversion. (300 words & fig.)

1938 621 .
The Oil Engine, No. 63, Mid July, p. 72.
Latest developments with Büchi exhaust turbo-char ing. (1 300 words & fig.)

1938 621 .43 (.8
The Oil Engine, No. 63, Mid July, p. 75.
Two-stroke 900 b. h. p. diesel locomotives. (600 wor & fig.)

1938 621 .43 (.4
The Oil Engine, No. 63, Mid July, p. 76.
British **oil engines for railway traction.** (2 400 wor & fig.)

1938 621 .
The Oil Engine, No. 63, Mid July, p. 81.
Single or multiple engines for **diesel rolling stoc** (1 200 words.)

1938 621 .43 (.4
The Oil Engine, No. 63, Mid July, p. 86.
Diesel locomotives for industrial purposes. (1 5 words & fig.)

1938 625 .232 (.4
The Oil Engine, No. 63, Mid July, p. 90.
The activities of **british rolling stock constructor** (1 400 words & fig.)

1938 625 .234 (.7
The Oil Engine, No. 63, Mid July, p. 96.
Air conditioning and ventilation. (1 000 words & fig

1938 621 .43 (.4
The Oil Engine, No. 63, Mid July, p. 98.
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CHAUSSETTE (G.). — Die Ergänzung der **Hauptsignale** durch besondere Zeichen. (2 700 Wörter & Abb.)

Zeitschrift des Vereines deutscher Ingenieure (Berlin.)

1938 **621 .33 (.436)**

Zeitschr. des Ver. deutsch. Ing., Nr. 30, 23. Juli, S. 873.

DITTES (P). — Die **Elektrisierung** der ehemaligen österreichischen Bundesbahnen. (4 800 Wörter & Abb.)

1938 **385 .113 (.43)**

Zeitschr. des Ver. deutsch. Ing., Nr. 30, 23 Juli, S. 883.

Die **Deutsche Reichsbahn** im Jahre 1937. (1 700 Wörter.)

1938 **621 .134.1**

Zeitschr. des Ver. deutsch. Ing., Nr. 30, 23. Juli, S. 891.

Messungen an neuartigen Lokomotiv-Treibstangen und Kolbenstangenbefestigungen. (800 Wörter & Abb.)

1938 **62. (01 & 624 .91**

Zeitschr. des Ver. deutsch. Ing., Nr. 31, 30. Juli, S. 911.

STOY (W.), EGNER (K.) & ERDMANN (W.). — Versuche mit I-förmigen **Holzbalken.** (3 600 Wörter & Abb.)

Zeitschrift für das gesamte Eisenbahn-Sicherungs- und Fernmeldewesen. (Berlin.)

1938 **656 .254**

Zeitschr. für das ges. Eisenbahn-Sicherungs- und Fernmeldewesen, Nr. 10, 1. August, S. 113.

WITTSCHELL (U.). — Die Sicherheit des Übertragungsvorgangs bei **induktiver Zugbeeinflussung** der Resonanzbauart. (4 000 Wörter & Abb.).

1938 **656 .253**

Zeitschr. für das ges. Eisenbahn-Sicherungs- und Fernmeldewesen, Nr. 10, 1. August, S. 119.

NITSCHKE. — **Sicherung von Gleisanschlüssen** ausserhalb der Bahnhöfe. (2 700 Wörter & Abb.)

Zeitung des Vereins mitteleuropäischer Eisenbahnverwaltungen. (Berlin.)

1938 **621 .33 (.436)**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw., Nr. 29, 21. Juli, S. 539.

KOCI (A.). — Die **Starkstromtechnik** im Dienste der Österreichischen Eisenbahnen. (7 600 Wörter & Abb.)

1938 **625 .1 (.481)**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw., Nr. 29, 21. Juli, S. 550.

PASZKOWSKI. — Zur **Eröffnung der Strecke Nelang-Kristiansand** der norwegischen Südlandbahn. (800 Wörter & Abb.)

1938 **621 .133.1 (.43**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw Nr. 30, 28. Juli, S. 560.

VELTE. — Weitere grundsätzliche Betrachtungen z den **Kohlenversuchsfahrtenergebnissen mit G 12-Lokomotiven** auf der Strecke Vorhalle-Altenhundem und be sonders in ihrer Anwendung auf andere Lokomotivga tungen und Betriebsverhältnisse. (2 600 Wörter Abb.)

1938 **385 .13 (.494**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw Nr. 30, 28. Juli, S. 566.

Streifzug durch das schweizerische **Eisenbahnkonzessionsrecht.** (3 500 Wörter.)

1938 **385 .113 (.49**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw Nr. 30, 28. Juli, S. 570.

Die **Niederländischen Eisenbahnen** 1937. (900 Wörter.)

1938 **656 .224 (.43**

Zeitung des Vereins mitteleuropäischer Eisenbahnverw Nr. 31, 4. August, S. 577.

BOGSCH (A.). — Die **Leistungen der Ungarisch Staatsbahnen** gelegentlich der Eröffnung des « St. Stefan-Jahres » und des Eucharistischen Kongresses. (3 0 Wörter.)

1938 **385 .4 (.4**

Zeitung des Vereins mitteleuropäischer Eisenbahnver Nr. 31, 4. August, S. 581.

Die **Neuordnung** der französischen Eisenbahnen. (3 7 Wörter.)

1938 **656 .21**

Zeitung des Vereins mitteleuropäischer Eisenbahnver Nr. 32, 11. August, S. 593; Nr. 33, 18. August, S. 6

KOPP (G.) — Der **Einfluss der Langsamfahrstrecke der Eisenbahnen auf Fahrplan und Kosten.** (9 000 Wörter & Abb.)

1938 **625 .5 (.43**

Zeitung des Vereins mitteleuropäischer Eisenbahnver Nr. 32, 11. August, S. 601.

CZITARY (E.). — Die Entwicklung der Österreichischen **Personenseilschwebebahnen.** (1 900 Wörter Abb.)

1938 **621 .32 (.4**

Zeitung des Vereins mitteleuropäischer Eisenbahnver Nr. 33, 18. August, S. 611.

CAPELLE (G.). — Zehn Jahre **elektrischer Betr** auf der Berliner S-Bahn. (2 900 Wörter & Abb.)

In English.

Bulletin, American Railway Engineering Association. (Chicago.)

1938 **625 .143.3 (.**

Bulletin, Amer. Ry. Engineer. Association, No. 404, Ju July, p. 3.

Fourth progress report of the joint investigation **fissures in railroad rails.** (12 500 words & fig.)

938 625 .14 (01
letin, Amer. Ry. Engineer. Association, No. 404, June-July, p. 53.
Discussion on stresses in railroad track. (6 300 words ig.)

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938 62. (01, 621 .133.3 & 621 .133.7
letin, Amer. Ry. Engineer. Association, No. 404, June-July, p. 73.
Cause of and remedy for pitting and corrosion of lo- iotive boiler tubes and sheets, with special reference status of embrittlement investigation. (8 400 words ables.)

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938 313 : 625 .142 (.73)
letin, Amer. Ry. Engineer. Association, No. 404, June-July, 9. 97.
Preliminary report of Committee III — Ties. (400 rds.)

Engineer. (London.)

938 621 .83
gineer, No. 4306, July 22, p. 84; No. 4307, July 29, p. 110; No. 4308, August 5, p. 138 and No. 4309, August 12, p. 166.
MERRITT (H. E.). — Gear performance. (20 000 rds & fig.)

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938 656 .222.1 (.42)
gineer, No. 4306, July 22, p. 89.
. N. E. R. speed record. (200 words.)

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938 621 .9 & 721 .3
gineer, No. 4306, July 22, p. 100.
Pole-setting equipment. (800 words & fig.)

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938 385. (071 (.42) & 385 .586 (.42)
gineer, No. 4307, July 29, p. 118.
. M. S. school of transport at Derby. (2 600 words ig.)

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938 621 .133.4
rineer, No. 4307, July 29, p. 123.
ocomotive chimneys. (1 000 words.)

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938 625 .122
ineer, No. 4308, August 5, p. 140.
og blasting. (1 800 words & fig.)

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938 621 .131.3
ineer, No. 4308, August 5, p. 142.
he counter pressure brake test of locomotives. (1 700 ls & fig.)

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938 624 .63 (.460)
ineer, No. 4308, August 5, p. 147.
ne Elsa viaduct, Spain. (1 300 words & fig.)

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938 313 : 656 .28 (.42)
neer, No. 4308, August 5, p. 157 and No. 4309, August 12, p. 177.
ilway accidents in 1937. (3 300 words.)

Engineering. (London.)

1938 621 .89
Engineering, No. 3784, July 22, p. 91.
FINCH (G. I.) and WHITMORE (E. J.). — The graphoid layer on bearing surfaces. (1 100 words & fig.)

1938 669 .1
Engineering, No. 3784, July 22, p. 110.
The Thermoloys process for the manufacture of steel castings. (1 500 words.)

1938 621 .8
Engineering, No. 3784, July 22, p. 115.
The Platt dry multiple-disc clutch. (800 words & fig.)

1938 62. (01 & 69
Engineering, No. 3785, July 29, p. 124 and No. 3787, August 22, p. 198.
KING (A. J.). — The reduction of structure-borne noise by vibration-attenuating supports. (4 700 words.)

1938 385 .586 (.42)
Engineering, No. 3785, July 29, p. 126.
The school of railway transport at Derby. (1 000 words & fig.)

1938 621 .132.3 (.42)
Engineering, No. 3785, July 29, p. 127.
The conversion of a L. N. E. R. Atlantic-type locomotive. (300 words.)

1938 621 .13 (06 (.73)
Engineering, No. 3785, July 29, p. 136.
American locomotive operation. (2 100 words.)

1938 62. (01
Engineering, No. 3785, July 29, p. 143.
THUM (A.). — Research on materials, and modern design. (4 600 words.)

1938 613 .66
Engineering, No. 3786, August 5, p. 159.
Fume extractor for welding operations. (500 words & fig.)

1938 313 : 656 .28 (.42)
Engineering, No. 3786, August 5, p. 159.
British railway accidents, 1937. (800 words.)

1938 621 .89
Engineering, No. 3786, August 5, p. 170.
Friction in oscillating bearings. (1 000 words.)

1938 669 .1
Engineering, No. 3786, August 5, p. 176.
SARJANT (Dr. R. J.). — Open-hearth furnace design and control. (1 800 words & fig.)

1938 625 .232 (.42)
Engineering, No. 3786, August 5, p. 177.
New trains for the London-Bournemouth service on the Southern Railway. (700 words & fig.)

1938 **621 .9**
Engineering, No. 3787, August 12, p. 183.
TURNER (A.) and ROLT (F. H.). — **End-gauge comparator of high sensitivity.** (2 800 words & fig.)

1938 **625 .212 (.494)**
Engineering, No. 3787, August 12, p. 188.
The Brown-Boveri Simplex bogie. (900 words & fig.)

1938 **621 .392 (.42) & 621 .116 (.42)**
Engineering, No. 3787, August 12, p. 189.
British Corporation **rules for welded pressure vessels.** (400 words.)

1938 **691 & 693**
Engineering, No. 3787, August 12, p. 195.
The chemistry of cements. (2 100 words.)

Engineering News-Record. (New York.)

1938 **624. (0 (.73)**
Engineering News-Record, No. 2, July 14, p. 51.
RICKETTS (E. G.). — **Safeguarding bridges by inspection.** (3 300 words & fig.)

1938 **62. (01 & 691**
Engineering News-Record, No. 2, July 14, p. 60.
Developments in **engineering materials.** (6 000 words.)

1938 **698**
Engineering News-Record, No. 3, July 21, p. 88.
MARTIN (P. T.). — **How to paint road signs cheaply.** (2 100 words & fig.)

1938 **625 .14 (.73)**
Engineering News-Record, No. 4, July 28, p. 103.
Permanent track. (700 words.)

1938 **625 .14 (.73)**
Engineering News-Record, No. 4, July 28, p. 105.
Slabs support railroad track. (1 500 words & fig.)

1938 **624 .63 (.73)**
Engineering News-Record, No. 4, July 28, p. 110.
High level bridge corrects bad alignment. (1 600 words & fig.)

1938 **624 .63 (.73)**
Engineering News-Record, No. 4, July 28, p. 112.
CARLTON (Wm. W.). — **Long-span timber arch centering.** (1 800 words & fig.)

1938 **62. (01**
Engineering News-Record, No. 4, July 28, p. 115.
Timber and concrete strength. (2 500 words.)

1938 **625 .13 (.73)**
Engineering News-Record, No. 5, August 4, p. 137.
Bridge replacement under busy tracks. (3 200 words & fig.)

1938 **62. (01 & 69**
Engineering News-Record, No. 5, August 4, p. 141.
Measuring concrete vibrations. (400 words & fig.)

1938 **625 .13 (.73**
Engineering News-Record, No. 5, August 4, p. 145.
COHEN (A. B.). — **Centering hung from pier umbrellas.** (1 300 words & fig.)

1938 **624. (0 & 624**
Engineering News-Record, No. 5, August 4, p. 147.
LAMBERT (B. J.) and POSEY (C. J.). — **Handli[ng] corners in rigid frames.** (1 800 words & fig.)

Journal, Institution of Engineers, Australia. (Sydney, N. S. W.)

1938 **62. (01 & 621 .1**
Journal, Institution of Engineers, Australia, No. 6, Ju[ne], p. 203.
THYER (A. M.). — Design of **piping for high temp[er]atures and pressures.** (10 000 words & fig.)

Mechanical Engineering. (New York.)

1938 **621**
Mechanical Engineering, No. 8, August, p. 601.
ROSEN (C. G.). — Mechanical problems in **diesel-tr[ac]tor design.** (5 000 words & fig.)

1938 **621 .**
Mechanical Engineering, No. 8, August, p. 610.
BUMGARDNER (H. E.). — **Smoke-density measu[re]ments.** (2 600 words & fig.)

1938 **621**
Mechanical Engineering, No. 8, August, p. 631.
Hydraulic couplings. (1 200 words & fig.)

Modern Transport. (London.)

1938 **625 .4 (.**
Modern Transport, No. 1010, July 23, p. 3.
London transport tube railway extensions. (2 words & fig.)

1938 **385. (071 (.42) & 385 .586 (.**
Modern Transport, No. 1011, July 30, p. 3.
Completion of L. M. S. school of transport. (2 words & fig.)

1938 **656 .254 (.**
Modern Transport, No. 1011, July 30, p. 5.
Train control on the G. W. R. (1 700 words & f

1938 **625 .232 (.**
Modern Transport, No. 1011, July 30, p. 11.
New Southern Railway **rolling stock.** (1 400 w & fig.)

938 656 .257 (.42)
dern Transport, No. 1012, August 6, p. 3.
Iodernised signalling on the L. N. E. R. Relay interking with route-setting control. (3 000 words & fig.)

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938 313 : 656 .28 (.42)
dern Transport, No. 1012, August 6, p. 7.
British railway accidents in 1937. High safety stand maintained. (1 900 words.)

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938 625 .245 (.42) & 656 (.42)
dern Transport, No. 1012, August 6, p. 10.
Development of road-rail transport. No. 3 — Transable vehicles. (1 500 words & fig.)

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oceedings, Institution of Mechanical Engineers. (London.)

938 62. (01 & 621 .9
oceedings, Institution of mechanical Engineers, vol. 138. January-April, p. 59.
SCHLESINGER (Dr.-Ing. G.). — **Machine tool tests alignments.** (17 500 words & fig.)

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938 536
oceedings, Institution of mechanical Engineers, vol. 138. January-April, p. 229.
BINNIE (A. M.) and WOODS (M. W.). — The pres**e distribution** in a convergent-divergent steam nozzle. 000 words & fig.)

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938 532 & 533
oceedings, Institution of mechanical Engineers, vol. 138. January-April, p. 267.
DOWSON (R.). — **The effect of circumferential pitch steam turbine blades on torque** as compared with « bine effect » on the « lift » of aerofoils. (16 000 words fig.)

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938 621 .43
oceedings, Institution of mechanical Engineers, vol. 138. January-April, p. 367.
FARMER (H. O.). — **Exhaust systems of two-stroke gines.** (14 500 words & fig.)

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938 621 .43
oceedings, Institution of mechanical Engineers, vol. 138. January-April, p. 415.
DRINKWATER (J. W.) and EGERTON (Prof. A. C.). The **combustion process** in the compression-ignition gine. (24 000 words & fig.)

Railway Age. (New York.)

938 625 .232 (.42)
ilway Age, No. 3, July 16, p. 105.
New trains of the London and North Eastern have urious appointments. (2 300 words & fig.)

1938 656 .259
Railway Age, No. 3, July 16, p. 109.
Short-arm gates added to flashing-light crossing signals. (1 700 words & fig.)

1938 621 .133.7 (.73)
Railway Age, No. 3, July 16, p. 113.
Locomotive boiler water. — A big problem on the railways. (1 800 words & fig.)

1938 656 .234 (.73)
Railway Age, No. 3, July 16, p. 114.
Deadheats of 1937. (1 400 words.)

1938 385 .57 (.73) & 385 .586 (.73)
Railway Age, No. 3, July 16, p. 116.
Selecting and training employees. (2 400 words.)

1938 62. (01 (.73) & 621 .134.1 (.73)
Railway Age, No. 4, July 23, p. 135.
Locomotive axle testing. (2 200 words & fig.)

1938 656 .1 (.73)
Railway Age, No. 4. July 23, p. 145.
Executives scan Highway Transport in reports. (5 200 words.)

1938 621 .139 (.73) & 625 .27 (.73)
Railway Age, No. 4, July 23, p. 149.
Purchases and stores division reviews year's work. (15 000 words.)

1938 625 .143.3 (.73)
Railway Age, No. 4, July 23, p. 160.
MOORE (Dr. H. F.). — **Means to prolong rail life** featured in investigation. (2 900 words.)

1938 625 .258 (.73) & 656 .212.5 (.73)
Railway Age, No. 5, July 30, p. 180.
Belt railway rebuilds **clearing classification yard.** (6 000 words & fig.)

1938 625 .232 (.73)
Railway Age, No. 5, July 30, p. 186.
Renovated Western Maryland coaches are **air conditioned.** (1 500 words & fig.)

1938 347 .763 (.73) & 656 .1 (.73)
Railway Age, No. 5, July 30, p. 188.
60-hour week for truck drivers. (2 400 words.)

1938 385 .15 (.725) & 385 .4 (.725)
Railway Age, No. 5, July 30, p. 190.
Workers take over Mexican Railways. (2 300 words & fig.)

1938 656 .212.6 (.73)
Railway Age, No. 5, July 30, p. 193.
Railway express installs novel conveyor at New York Terminal. (1 900 words & fig.)

1938 **385. (072 (.73)**
Railway Age, No. 6, August 6, p. 213.
Denver and Rio Grande Western builds new **testing laboratory.** (2 800 words & fig.)

1938 **625 .251**
Railway Age, No. 6, August 6, p. 216.
The friction of brake shoes at high speed and high pressure. (3 900 words & fig.)

1938 **621 .335 & 621 .43**
Railway Age, No. 6, August 6, p. 220.
« Ugly Duckling » becomes a Swan. **(Appearance evolution of the Diesel-electric switcher.)** (1 300 words & fig.)

Railway Engineering and Maintenance. (Chicago.)

1938 **625 .173 (.73) & 665 .882 (.73)**
Railway Engineering and Maintenance, August, p. 476.
Building-up rail ends with multiple-flame torches. (3 400 words & fig.)

1938 **721 .2 (.73)**
Railway Engineering and Maintenance, August, p. 480.
STALEY (H. R.). — **Leaky brick walls.** (3 700 words & fig.)

1938 **625 .17 (.73)**
Railway Engineering and Maintenance, August, p. 484.
CLARKE (H. R.). — **Meeting today's demands, in maintenance.** (3 500 words.)

1938 **625 .19**
Railway Engineering and Maintenance, August, p. 487.
Power augur cuts tunnel for jacking culvert pipe. (1 400 words & fig.)

Railway Gazette. (London.)

1938 **625 .232 (.82)**
Railway Gazette, No. 4, July 22, p. 156.
New Argentine **coaching stock.** (600 words & fig.)

1938 **625 .143.5 (.42)**
Railway Gazette, No. 4, July 22, p. 157.
An effective fastening for **flat-bottom track.** (400 words & fig.)

1938 **625 .216 & 625 .23 (0**
Railway Gazette, No. 4, July 22, p. 158.
Mr. Cantlie on **minimising the risk of telescoping.** (1 800 words.)

1938 **625 .216 (.42)**
Railway Gazette, No. 4, July 22, p. 159.
A new **shock-absorber.** (300 words & fig.)

1938 **656 .212 (.42**
Railway Gazette, No. 4, July 22, p. 161.
King's Cross **goods station remodelling,** L. N. E. R (2 100 words & fig.)

1938 **625 .1 (.55**
Railway Gazette, No. 4, July 22, p. 165.
Further progress of the **Trans-Iranian Railway.** (8(words & fig.

1938 **625 .213 (.73) & 625 .232 (.73**
Railway Gazette, No. 4, July 22, p. 168.
Pendulum suspension for railway vehicles. (3(words & fig.)

1938 **621 .94 (.42**
Railway Gazette, No. 4, July 22, p. 169.
Axle grinding at Swindon locomotive works, Great Western Railway. (300 words & fig.)

1938 **625 .232 (.42**
Railway Gazette, No. 5, July 29, p. 203.
Modernised trains, Southern Railway. (1 600 words & fig.)

1938 **625 .232 (.43**
Railway Gazette, No. 5, July 29, p. 204.
Lübeck-Büchen double-deck trains. (1 500 words 1 map.)

1938 **385. (071 (.42) & 385 .586 (.4**
Railway Gazette, No. 5, July 29, p. 206.
The L. M. S. R. **school of transport.** (2 400 wor & fig.)

1938 **656 .1 (.5**
Railway Gazette, No. 5, July 29, p. 216.
Solving the **railway road transport problem** in Ind (1 600 words & fig.)

1938 **621 .43 (.4**
Railway Gazette, No. 5, July 29, p. 218.
A. E. C. direct-injection oil engine. (800 words & fi

1938 **313 : 656 .28 (.4**
Railway Gazette, No. 6, August 5, p. 236.
Colonel Mount's annual report. (3 300 words.)

1938 **614 .8 (.4**
Railway Gazette, No. 6, August 5, p. 244.
Presenting the facts about accidents. (900 words.

1938 **656**
Railway Gazette, No. 6, August 5, p. 245.
TOWERS (H. C.). — **Power signalling circuits.** (1 words.)

1938 **725 .31 (.9**
Railway Gazette, No. 6, August 5, p. 246.
New station for Christchurch, New Zealand. (1 words & fig.)

1938 621 .132.3 (.42)
ilway Gazette, No. 6, August 5, p. 248.
4-6-2 type locomotives, L. M. S. R. (200 words & fig.)

1938 621 .132.3 (.44) & 621 .392 (.44)
ilway Gazette, No. 6, August, 5, p. 251.
Rebuilt locomotives with welded cylinders in France. 00 words & fig.)

1938 669
ilway Gazette, No. 7, August 12, p. 292.
SALMONY (Dr. A.). — Modern cast iron and steel for ilway use. (3 900 words.)

1938 656 .254 (.42)
ilway Gazette, No. 7, August 12, p. 295.
Automatic train control on L. M. S. R. (2 200 words fig.)

1938 621 .132.3 (.91)
ilway Gazette, No. 7, August 12, p. 300.
New three-cylinder locomotives for the Federated Ma- y States Railways. (800 words & fig.)

1938 621 .43 (.497.1)
esel Railway Traction, p. 266, supplt. to the Railway Gazette, August 5.
Express narrow-gauge diesel-mechanical trains in Ju- slavia. (7 000 words & fig.)

1938 621 .43 (.51)
esel Railway Traction, p. 276, supplt. to the Railway Gazette, August 5.
An improved railcar in China. (700 words & fig.)

1938 62. (01 & 669
esel Railway Traction, p. 278, supplt. to the Railway Gazette, August 5.
Scientific control in light alloy manufacture. (1 300 rds & fig.)

1938 621 .31 & 656 .234
ectric Railway Traction, p. 186, supplt. to the Railway Gazette, July 22.
Mercury vapour rectifiers in the supply of current to lway systems. (900 words & fig.)

1938 621 .338 (.45)
ectric Railway Traction, p. 187, supplt. to the Railway Gazette, July 22.
Stainless steel stock in Italy. (200 words & fig.)

1938 621 .33 (.73)
ectric Railway Traction, p. 188, supplt. to the Railway Gazette, July 22.
A middle-west electrified line. (900 words & fig.)

1938 621 .335 & 625 .21
ectric Railway Traction, p. 189, supplt. to the Railway Gazette, July 22.
CROFT (E. H.). — The electric locomotive as a vehi- . (2 500 words & fig.)

Railway Magazine. (London.)

1938 656 .222.1 (.42)
Railway Magazine, No. 494, August, p. 79.
ALLEN (C. J.). — Two miles a minute. The new L. N. E. R. record of 125 miles an hour. (1 000 words & fig.)

1938 625 .114 (.44)
Railway Magazine, No. 494, August, p. 82.
The main-line gradients of French Railways. (1 600 words.)

1938 656 .222.1 (.44)
Railway Magazine, No. 494, August, p. 85.
Recent French locomotive performance, 1. — Eastern Region. (1 300 words & fig.)

1938 656 .222.1 (.42)
Railway Magazine, No. 494, August, p. 89.
ALLEN (C. J.). — British locomotive practice and performance. (4 800 words & fig.)

1938 621 .33 (.42)
Railway Magazine, No. 494, August, 102.
West Sussex electrification, Southern Railway. (2 700 words & fig.)

1938 625 .232 (.42)
Railway Magazine, No. 494, August, p. 111.
The new Flying Scotsman. (2 000 words & fig.)

1938 625 .4 (.42)
Railway Magazine, No. 494, August, p. 119.
ELLIS (C. H.). — The Glasgow underground lines. (3 400 words & fig.)

Railway Mechanical Engineer. (New York.)

1938 621 .132.3 (.73)
Railway Mechanical Engineer, No. 7, July, p. 245.
Southern Pacific receives second lot of streamline 4-8-4 locomotives. (1 800 words.)

1938 621 .13 (06 (.73)
Railway Mechanical Engineer, No. 7, July, p. 247.
Mechanical Division reports. Locomotive construction. Steam locomotive development. Car construction, etc. (12 500 words, tables & fig.)

Railway Signaling. (Chicago.)

1938 656 .257 (.73)
Railway Signaling, August, p. 452.
ZANE (W. F.). — C. B. & Q. installs code type interlocking. (3 000 words & fig.)

1938 625 .258 (.73) & 656 .212.5 (.73)
Railway Signaling, August, p. 456.
Car retarders at clearing yard in Chicago. (7 000 words & fig.)

1938 621 .33 (.73) & 656 .25 (.73)
Railway Signaling, August, p. 464.
Communication construction on the Pennsylvania electrification. (1 400 words & fig.)

1938 656 .25 (0 (.73)
Railway Signaling, August, p. 467.
Missouri Pacific improves **signaling performance.** (1 700 words & fig.)

1938 656 .25 (0
Railway Signaling, August, p. 473.
Railroad operation and railway signaling. (2 800 words & fig.)

South African Railways and Harbours Magazine. (Johannesburg.)

1938 625 .216 (.73) & 625 .232 (.73)
South African Railways and Harbours Magazine, July, p. 86.
New « **pendulum** » **train.** (600 words & fig.)

The Oil Engine. (London.)

1938 621 .43 (.43)
The Oil Engine, No. 64, Mid August, p. 108.
First German **four-unit Diesel train,** with restaurant car, propelled by a single engine. (1 900 words & fig.)

1938 621 .43 (.941) & 625 .144.4 (.941)
The Oil Engine, No. 64, Mid August, p. 110.
Portable unit for cutting sleepers. (200 words & fig.)

1938 621 .43 & 621
The Oil Engine, No. 64, Mid August, p. 116.
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an für die Fortschr. des Eisenbahnw., Heft 18. 15. September, S. 333.
CHACHENMEYER & LEUSSLER (R.). — Der Bau er festen **Eisenbahn- und Strassenbrücke** über den ein bei Karlsruhe-Maxau. (6 400 Wörter & Abb.)

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938 625 .154
an für die Fortschr. des Eisenbahnw., Heft 18. 15. September, S. 341.
ÖHLE. — **Drehscheiben** — **Rollschemel** zum Umzen von Eisenbahnwagen « System Marjollet ». 00 Wörter & Abb.)

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938 621 .131.3
an für die Fortschr. des Eisenbahnw., Heft 18. 15. September, S. 346.
rgebnisse von **Versuchslokomotiven.** (500 Wörter.)

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938 621 .43 & 669
an für die Fortschr. des Eisenbahnw., Heft 18, 15. September, S. 347.
eichtmetallverbrennungstriebwagen (Hydronaliumgen). (800 Wörter & Abb.)

Zeitung des Vereins Mitteleuropäischer Eisenbahnverwaltungen. (Berlin.)

938 385
tung des Ver. Mitteleurop. Eisenbahnverw., Nr. 34. 25. August, S. 629; Nr. 35, 1. September, S. 647.
LUM. — **Raumordnung und Güterverkehr.** (12 000 rter.)

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938 624 .32 (.43)
tung des Ver. Mitteleurop. Eisenbahnverw., Nr. 34, S. 635.
CHAPER. — Die beiden **neuen Rheinbrücken** bei xau und Speyer. (2 700 Wörter & Abb.)

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938 656 .212.5
tung des Ver. Mitteleurop. Eisenbahnverw., Nr. 36-37, 8. September, S. 678.
ROHME. — **Gefällbahnhöfe.** (7 700 Wörter.)

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938 625 .112
tung des Ver. Mitteleurop. Eisenbahnverw., Nr. 36-37, 8. September, S. 689.
IPPE. — **Von der Schmalspur zur Vollspur.** (3 200 rter & Abb.)

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938 621 .43 (.43)
ung des Ver. Mitteleurop. Eisenbahnverw., Nr. 36-37, 8. September, S. 696.
EIDEL. — **Triebwagen** der Deutschen Reichsbahn. 00 Wörter & Abb.)

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1938 621
Zeitsch. des Ver. deutsch. Ing., Nr. 34, 20. August, S. 969.
MÜNZINGER (F.). — Entwicklungsrichtungen im Bau von **Kraftmaschinen für Verkehrsmittel** und ortsfeste Anlagen. (11 000 Wörter & Abb.)

1938 625 .4 (.43)
Zeitsch. des Ver. deutsch. Ing., Nr. 35, 27. August, S. 1013.
GRABSKI. — Vom Bau der **Berliner Nordsüd-S-Bahn.** (4 800 Wörter & Abb.)

1938 621 .392
Zeitsch. des Ver. deutsch. Ing., Nr. 35, 27. August, S. 1027.
AUREDEN (H.). — **Stahlersparnis durch Schweissen.** (3 600 Wörter & Abb.)

1938 624. (.43)
Zeitsch. des Ver. deutsch. Ing., Nr. 37, 10. September, S. 1061.
AURNHAMMER (G.). — Kleinere **Brückenbauwerke** der Reichsautobahnen. (3 900 Wörter & Abb.)

1938 624 .62 (.43)
Zeitsch. des Ver. deutsch. Ing., Nr. 37, 10. September, S. 1073.
BRÜCKNER (K.). — Mit Bogengurt versteifte **stählerne Brücken.** (3 000 Wörter & Abb.)

1938 621 .392 & 665 .882
Zeitsch. des Ver. deutsch. Ing., Nr. 37, 10. September, S. 1079.
CORNELIUS (H.). — **Schweissen** von Stahlguss, Gusseisen und Temperguss. (8 400 Wörter & Abb.)

1938 62. (01 & 669 .1
Zeitsch. des Ver. deutsch. Ing., Nr. 38, 17. September, S. 1095.
BOLLENRATH (F.). — **Röntgenographische Spannungsmessungen** bei Überschreiten der Fliessgrenze an Biegestäben aus Flussstahl. (3 900 Wörter & Abb.)

1938 62. (01 & 621 .392
Zeitsch. des Ver. deutsch. Ing., Nr. 38, 17. September, S. 1101.
THUM (A.) & ERKER (A.). — Dauerbiegefestigkeit von **Kehl- und Stumpfnahtverbindungen.** (5 000 Wörter & Abb.)

1938 621 .13 & 621 .33
Zeitsch. des Ver. deutsch. Ing., Nr. 38, 17. September, S. 1114.
SCHMER (K.). — **Vergleich zwischen Lokomotiv- und Triebwagenbetrieb** im elektrischen Fernschnellverkehr. (800 Wörter & Abb.)

Zeitschrift für das gesamte Eisenbahn-Sicherungs- und Fernmeldewesen. (Berlin.)

1938 **656 .256.3**
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmeldewesen, Nr. 11, 20. August, S. 129.
BUDDENBERG (A.). — **Schienenstromschliesser.** (2 400 Wörter & Abb.)

1938 **656 .257**
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmeldewesen, Nr. 12, 10. September, S. 137.
REHSCHUH (G.). — **Fernsteuerung von Weichen und Signalen** mit Hilfe von Schrittschaltern. (4 000 Wörter & Abb.)

1938 **656 .253**
Zeitschr. für das ges. Eisenb.-Sicherungs- und Fernmeldewesen, Nr. 12, 10. September, S. 142.
NITSCHKE. — **Sicherung von Gleisanschlüssen** ausserhalb der Bahnhöfe. (1 700 Wörter & Abb.)

In English.

Engineer. (London.)

1938 **621 .83**
Engineer, No. 4310, August 19, p. 190.
MERRITT (H. E.). — **Gear performance.** (2 200 words & fig.)

1938 **62. (01**
Engineer, No. 4310, August 19, p. 196.
BAUER (S. G.). — **A mechanical-optical high-speed indicator.** (2 200 words & fig.)

1938 **625 .212 & 625 .214**
Engineer, No. 4310, August 19, p. 203.
Railway axle **wheel-seat failures.** (1 500 words.)

1938 **621 .137.1**
Engineer, No. 4310, August 19, p. 207.
LIVESAY (E. H.). — **Mechanical stokers** on locomotives. (1 000 words & fig.)

1938 **624 .32 (.42)**
Engineer, No. 4311, August 26, p. 222.
Waterloo bridge. (1 400 words & fig.)

1938 **662. (.42)**
Engineer, No. 4311, August 26, p. 230.
Forest gas for traction. (2 500 words.)

1938 **621 .31 (.42)**
Engineer, No. 4311, August 26, p. 233.
Carbon pile voltage regulators. (1 700 words & fig.)

1938 **621 .31**
Engineer, No. 4312, September 2, p. 260.
Arc suppression coil. (2 600 words & fig.)

1938 **627. (.71) & 656 .213 (.71**
Engineer, No. 4313, September 9, p. 270.
LEGGET (R. F.). — Some Canadian wharf structur **of steel sheet piling.** (7 000 words & fig.)

1938 **656 .212.6 (.42**
Engineer, No. 4313, September 9, p. 288.
Timber yard crane. (600 words & fig.)

1938 **669**
The Metallurgist, p. 145, supplt. to the Engineer, A gust 26.
Critical cooling rates. (1 300 words.)

1938 **669**
The Metallurgist, p. 146, supplt. to the Engineer, A gust 26.
The effect of boron on nickel steels. (1 600 wor & tables.)

1938 **536 & 669**
The Metallurgist, p. 152, supplt. to the Engineer, A gust 26.
Thermal conductivity of iron and steel. (1 500 wor & tables.)

1938 **669**
The Metallurgist, p. 154, supplt. to the Engineer, A gust 26.
Flakes in steel. (2 000 words & tables.)

1938 **669**
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Cast high-chromium manganese steels. (1 600 word

Engineering. (London.)

1938 **625 .1 (.4**
Engineering, No. 3788, August 19, p. 225.
The reconstruction of the Trent Valley Junction Stafford, L. M. S. R. (500 words & fig.)

1938 **62. (01 & 6**
Engineering, No. 3788, August 19, p. 232.
The measurement of vibration in fresh concrete. (2 words & fig.)

1938 **62. (01 & 624**
Engineering, No. 3789, August 26, p. 235 and No. 37 September 9, p. 295.
THOMPSON (F. C.), KENNEFORD (A. S.) a SEAGER (G. C.). — **The tensile stresses in a bea metal cast on to a strip and the « fatigue » failure bearings.** (3 500 words, tables & fig.)

1938 **533 & 62. (06 (.**
Engineering, No. 3789, August 26, p. 243.
ALLEN (R. W.). — Some experiences of the use **scale models in general engineering.** (4 000 words & fi

38 625 .212 (.42) & 656 .284 (.42)
ineering, No. 3789, August 26, p. 256.
e Rutherghen railway accident. (600 words.)

38 62. (01
ineering, No. 3789, August 26, p. 263.
CLES (G. O.). — Moving coil vibrometer. (1 800 ls & fig.)

38 625 .4 (.42) & 725 .31 (.42)
ineering, No. 3790, September 2, p. 265, and No. 3791, September 9, p. 296.
econstruction of King's Cross Underground station. 0 words & fig.)

38 621 .8
ineering, No. 3790, September 2, p. 268.
A (Prof. F. C.). — Hydro-kinetic power transmit- (5 500 words & fig.)

38 62. (01 (.42)
ineering, No. 3790, September 2, p. 281.
e British Association's meeting at Cambridge: que converter for motor cars. Railway braking and running times. Symposium on vibration, etc. 0 words.)

38 62. (01 & 691
ineering. No. 3790, September 2, p. 291.
xperiments on the freezing of building materials. 0 words.)

38 621 .7 (.73) & 621 .9 (.73)
ineering, No. 3791, September 9, p. 293.
IASE (H.). — Die-casting equipment and practice he United States. (2 400 words & fig.)

38 662
ineering, No. 3791, September 9, p. 299.
XWELL (G. E.). — Solid fuel for motor transport. 0 words.)

38 537 .7 & 621 .3
ineering, No. 3791, September 9, p. 317.
ASON (C. C.). — The trend of instrument design. 0 words.)

Engineering News-Record. (New York.)

38 624. (0 (.493)
ineering News-Record, No. 7, August 18, p. 204.
NDY (O.). — Brittle steel a feature of Belgian ge failure. (1 800 words & fig.)

38 624 .1 (.73)
ineering News-Record, No. 7, August 18, p. 207.
ilor-made cofferdams. (2 300 words & fig.)

38 624 (.73)
ineering News-Record, No. 8, August 25, p. 231.
ree major bridges completed this month: Thous- Islands composite bridge in New York. St. Clair r cantilever at Port Huron, Mich.; and Connecticut r bridge at Middletown, Conn., are scenes of con- ction achievements. (7 000 words & fig.)

1938 624 .2 (.73)
Engineering News-Record, No. 9, September 1, p. 265.
WHITE (E. A.). — High concrete bridge for low cost. (2 500 words & fig.)

Journal, Institution of Engineers, Australia. (Sydney, N. S. W.)

1938 62. (01 & 621 .39
Journal Institution of Engineers, Australia, No. 7, July, p. 243.
HIRST (H.). — X-rays in the engineering industry. (7 400 words & fig.)

1938 656. (.944)
Journal Institution of Engineers, Australia, No. 7, July, p. 257.
HAWKINS (C. A.). — Transport development on the north coast of New South Wales. (4 000 words.)

London & North Eastern Railway Magazine. (London.)

1938 621 .133.7
London & North Eastern Railway Magazine, No. 9, September, p. 496.
STEDMAN (C. M.). — Locomotive boiler feed water. (2 500 words & fig.)

Mechanical Engineering. (New York.)

1938 621 .9
Mechanical Engineering, No. 9, September, p. 666.
BRINKMAN (E. W.). — A new method in tooling automatic screw machines. (2 300 words & fig.)

1938 536
Mechanical Engineering, No. 9, September, p. 669.
Heat transfer to boiling liquids. (4 000 words & fig.)

1938 62. (0 & 669. (0
Mechanical Engineering, No. 9, September, p. 687.
BARCLAY (W. R.). — Contributions of metallurgy to engineering progress. (8 000 words & fig.)

1938 62. (01 & 625 .2 (0
Mechanical Engineering, No. 9, September, p. 696.
BERNHARD (R. K.). — Dynamic relations between moving loads and structures. (5 000 words & fig.)

Modern Transport. (London.)

1938 347 .763 & 656 .1
Modern Transport, No. 1013, August 13, p. 3.
Regulation of road transport. Organisation and obligations. An international survey. (2 000 words.)

1938 **656. (.51)**

Modern Transport, No. 1013, August 13, p. 4.

LOCHOW (H. J. von). — **Transport in China.** (1 700 words & 1 map.)

1938 **656 .254 (.42)**

Modern Transport, No. 1013, August 13, p. 5.

Automatic train control on L. M. S. R. (2 600 words & fig.)

1938 **625 .144.2 (.44) & 625 .245 (.44)**

Modern Transport, No. 1013, August 13, p. 6.

Measuring inaccuracies in railway curves. (700 words & fig.)

1938 **385. (.436)**

Modern Transport, No. 1013, August 13, p. 12.

Austrian Railways since the « Anschluss ». (1 700 words & fig.)

1938 **656 .211.3 (.42)**

Modern Transport, No. 1014, August 20, p. 3.

Two-level junction at Stafford. (1 400 words & fig.)

1938 **621 .335 (.498) & 621 .43 (.498)**

Modern Transport, No. 1014, August 20, p. 7.

Diesel-electric locomotive for Rumania. Experimental unit for State Railways. For express services on severe gradients. (800 words & fig.)

1938 **656**

Modern Transport, No. 1015, August 27, p. 3.

Transport and the trader. Existing systems of co-operation. (2 100 words.)

1938 **621 .43 (.54)**

Modern Transport, No. 1015, August 27, p. 5.

Oil-engined railcars for India. Equipped with Ganz-Jendrassik engines. A special railcar bogie. (800 words & fig.)

1938 **624. (.43)**

Modern Transport, No. 1016, September 3, p. 3.

Bridges on German **motor roads.** (1 300 words & fig.)

1938 **621 .43 (.82)**

Modern Transport, No. 1016, September 3, p. 5.

Oil-engined trains for Argentina. (900 words & fig.)

1938 **621 .331**

Modern Transport, No. 1017, September 10, p. 3.

LYDALL (Fr.). — **Power for electrified railways. Factors influencing energy consumption.** (3 400 words.)

1938 **656**

Modern Transport, No. 1017, September 10, p. 7.

DELANNEY (L.). — **Modern transport** and its problems. **Organisation and rates.** (1 900 words.)

New Zealand Railways Magazine. (Wellington.

1938 **625 .1 (.93**

New Zealand Railways Magazine, No. 4, July, p. 17

NEALE (E. P.). — The **heyday of railway constru**tion in New Zealand. (Concluded). (2 500 words & fig

Proceedings, American Society of Civil Engineers. (New York.)

1938 **721**

Proceedings, Americ. Soc. of Civil Engineers, No. September, p. 1319.

Lateral earth and concrete pressures. (3 700 wor & fig.)

1938 **62. (01 & 7**

Proceedings, Americ. Soc. of Civil Engineers, No. September, p. 1335.

Wind forces on a tall building. (11 000 words, tab & fig.)

1938 **621**

Proceedings, Americ. Soc. of Civil Engineers, No. September, p. 1377.

Transportation of sand and gravel in a four-inch pi (4 800 words & fig.)

1938 **725**

Proceedings, Americ. Soc. of Civil Engineers, No. September, p. 1475.

Water-softening plant design. (8 000 words.)

1938 **656**

Proceedings, Americ. Soc. of Civil Engineers, No. September, p. 1489.

Motor transportation. — A forward view. (8 3 words.)

Railway Age. (New York.)

1938 **621 .335 (.73) & 621 .43 (.7**

Railway Age, No. 7, August 13, p. 244.

Light-weight diesel-electric trains. (4 500 wo & fig.)

1938 **656 .1 (.7**

Railway Age, No. 7, August 13, p. 249.

Santa Fe begins **co-ordinated** California serv (2 400 words & fig.)

1938 **654. (.7**

Railway Age, No. 7, August 13, p. 252.

Printing telegraph system on the Denver & Grande Western. (3 200 words & fig.)

1938 **625 .144.4 (.73) & 625 .17 (.**

Railway Age, No. 8, August 20, p. 278.

KNOWLES (C. R.). — **Work equipment** — An **to economies in maintenance of way work.** (4 000 wo & fig.)

938 625 .243 (.73)
way Age, No. 8, August 20, p. 284.
dditional **wagon-top box cars** built by the Balti-
e & Ohio. (1 100 words & fig.)

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938 656 .1 (.73)
way Age, No. 8, August 20, p. 287.
terstate Commerce Commission acts to halt **motor**
wars. (2 000 words.)

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938 621 .132.3 (.73)
way Age, No. 9, August 27, p. 305.
treamline locomotives for the Chicago & North
tern. (2 500 words & fig.)

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938 625 .144.2 & 691
way Age, No. 9, August 27, p. 308.
ood preservation and the Railways. (15 000 words
ig.)

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938 656 .261 (.73)
way Age, No. 9, August 27, p. 322.
ail-highway transport of milk. (1 600 words & fig.)

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938 698. (.73) & 725 .33 (.73)
way Age, No. 10, September, 3, p. 343.
xperiments **with glass blocks in enginehouses.** (1 800
ds & fig.)

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938 62. (01 & 621 .133.7
way Age, No. 10, September 3, p. 345.
itting and corrosion in locomotive boilers. (1 900
ds.)

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938 656 .257 (.73)
way Age, No. 10, September 3, p. 348.
ANE (W. F.). — **Interlocking** three miles long on
Burlington. (2 000 words & fig.)

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938 621 .43 (.73)
way Age, No. 11, September 10, p. 367.
avenport-Besler builds 105-ton **diesel electric swit-**
. (2 300 words & fig.)

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938 62. (01 (.73) & 721 .1 (.73)
way Age, No. 11, September 10, p. 370.
uilding above steam operation presents problems.
00 words & fig.)

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938 621 .139 (.73) & 625 .27 (.73)
way Age, No. 11, September 10, p. 381.
udy throws light on **railroad scrap.** (1 200 words
ig.)

Railway Engineering and Maintenance. (Chicago.)

938 625 .17
way Engineering and Maintenance. Septemb., p. 532.
ILLIAMS (A. N.). — An executive looks at **main-**
nce problems. (2 400 words.)

1938 **621 .9 (.73) & 625 .143.5**
Railway Engineering and Maintenance, Septemb., p. 534.
This **machine reclaims spikes** at rate of 21.6 per
minute. (200 words & fig.)

1938 **624 & 691**
Railway Engineering and Maintenance, Septemb., p. 536.
New **trestle fire-stop** appears effective. (1 200 words
& fig.)

1938 **621 .9 (.73) & 625 .144.4 (.73)**
Railway Engineering and Maintenance, Septemb., p. 538.
EDWARDS (C. R.). — How the Wabash **repairs**
work equipment. (4 800 words & fig.)

1938 **625 .172 (.42)**
Railway Engineering and Maintenance, Septemb., p. 541.
How **accurate surfacing.** (1 300 words & fig.)

1938 **721 .1 (.73)**
Railway Engineering and Maintenance, Septemb., p. 542.
LAIRD (A. N.). — **Underpinning of freight office**
overcomes settlement. (900 words.)

1938 **313 : 656 .285 (.73) & 625 .17 (.73)**
Railway Engineering and Maintenance, Septemb., p. 544.
CHINN (A.). — **Accidents,** a challenge to railway
employees. (1 200 words.)

1938 **62. (01 & 625 .15**
Railway Engineering and Maintenance, Septemb., p. 545.
Service records of heat-treated crossings. (400 words
& fig.)

Railway Gazette. (London.)

1938 **621 .87**
Railway Gazette, No. 8, August 19, p. 323 and No. 9,
August 26, p. 365.
DALZIEL (J.). — **Cranes for railway purposes — I.**
(6 000 words.)

1938 **656 .222.4 (.492) & 656 .222.5 (.492)**
Railway Gazette, No. 8, August 19, p. 325.
Some problems of the **new Netherlands timetable.**
(1 400 words & fig.)

1938 **621 .138.5 (.42) & 621 .9 (.42)**
Railway Gazette, No. 8, August 19, p. 328.
Machining a locomotive detail (1 100 words & fig.)

1938 **625 .1 (.42)**
Railway Gazette, No. 8, August 19, p. 331.
Reconstruction of Stafford **Junction,** L. M. S. R.
(700 words & fig.)

1938 **656 .29 (.43)**
Railway Gazette. No. 9, August 26, p. 367.
Portable weighing machine for goods wagons. (200
words & fig.)

1938 **621 .132.3 (.62)**
Railway Gazette, No. 9, August 26, p. 368.
Mixed traffic locomotives for Egypt. (600 words & fig.)

1938 **625 .216 (.4)**
Railway Gazette, No. 9, August 26, p. 370.
ZEHNDER (Dr.-Ing.). — **Automatic couplers** on European rolling stock. (1 700 words & fig.)

1938 **625 .154 (.54)**
Railway Gazette, No. 9, August 26, p. 372.
Vacuum-worked 85-foot turntable North Western Railway, India. (400 words & fig.)

1938 **621 .132.3 (.44)**
Railway Gazette, No. 10, September 2, p. 401.
Improvements to P. L. M. **express engines.** (1 100 words & fig.)

1938 **625 .253 (.43)**
Railway Gazette, No. 10, September 2, p. 402.
Colour-light signals in Germany. (600 words.)

1938 **625 .14 (.492)**
Railway Gazette, No. 10, September 2, p. 403.
Netherlands Railways **permanent way.** (300 words & fig.)

1938 **625 .242 (.68)**
Railway Gazette, No. 10, September 2, p. 406.
All-steel wagons for South African Railways. (300 words & fig.)

1938 **651. (.931) & 657. (.931)**
Railway Gazette, No. 10, September 2, p. 407.
Mechanical accounting on the New Zealand Railways. (1 200 words & fig.)

1938 **625 .232 (.73)**
Railway Gazette, No. 10, September 2, p. 410.
American **grill cars.** (500 words & fig.)

1938 **625 .244 (.43)**
Railway Gazette, No. 10, September 2, p. 411.
German **refrigerator wagons.** (200 words & fig.)

1938 **625 .232 (.73)**
Railway Gazette, No. 11, September 9, p. 451.
The New Broadway & Twentieth Century Limited new **lightweight streamlined trains** for the accelerated New York-Chicago schedules of the Pennsylvania and the New York Central. (1 300 words & fig.)

1938 **656 .25 (.81)**
Railway Gazette, No. 11, September 9, p. 455.
Power signalling in Brazil. (1 100 words & fig.)

1938 **656 .257 (.42)**
Railway Gazette, No. 11, September 9, p. 459.
Quick replacement, in 13 days, **of a burnt signal box** on the Southern Railway. (1 600 words & fig.)

1938 **621 .43 (.931**
Diesel Railway Traction, p. 424, Supplt. to the Railwa
Gazette, September 2.
Main-line diesel-hydraulic railcars, for New Zealan
(2 000 words & fig.)

1938 **621 .43 (.941**
Diesel Railway Traction, p. 429, Supplt. to the Railwa
Gazette, September 2.
West Australian **railcars.** (400 words & fig.)

1938 **621 .43 (.8**
Diesel Railway Traction, p. 430, Supplt. to the Railwa
Gazette, September 2.
KOFFMANN (J. L.). — **Steam railcar converted diesel.** (1 800 words & fig.)

1938 **621 .43 (.4**
Diesel Railway Traction, p. 433, Supplt. to the Railwa
Gazette, September 2.
A new **locomotive oil engine.** (800 words & fig.)

1938 **621 .335 (.43) & 621 .43 (.4**
Diesel Railway Traction, p. 434, Supplt. to the Railw
Gazette, September 2.
Fifteen new **diesel flyers** in Germany. (1 500 wor & fig.)

1938 **621 .**
Diesel Railway Traction, p. 438, Supplt. to the Railw
Gazette, September 2.
A **supercharged railcar engine.** (600 words & fig.)

1938 **621 .33 (.45) & 656 .222.1 (.4**
Electric Railway Traction, p. 345, Supplt. to the Railw
Gazette, August 19.
86 m. p. h. schedule in Italy. (500 words.)

1938 **621 .33 (.46**
Electric Railway Traction, p. 346, Supplt. to the Railw
Gazette, August 19.
Electrification of Spanish Provincial line complet (700 words & fig.)

1938 **621 .335 (.45) & 621 .338 (.4**
Electric Railway Traction, p. 347, Supplt. to the Railw
Gazette, August 19.
Fast motor-coaches for solo work in Italy. (700 wo & fig.)

1938 **621 .33 (.494) & 625 .3 (.49**
Electric Railway Traction, p. 348, Supplt. to the Railw
Gazette, August 19.
Swiss **rack railway electrification.** (600 words & fi

1938 **621 .338 (.6**
Electric Railway Traction, p. 349, Supplt. to the Railw
Gazette, August 19.
New **electric stock** for the Transvaal. (400 wo & fig.)

938 621 .333
ctric Railway Traction, p. 350, Supplt. to the Railway Gazette, August 19.
typical modern **nose-suspended motor.** (500 words ig.)

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938 621 .331 (.68) & 656 .254 (.68)
ctric Railway Traction, p. 353, Supplt. to the Railway Gazette, August 19.
ectifier plants and communication interference. 00 words.)

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938 621 .331
ctric Railway Traction, p. 472, Supplt. to the Railway Gazette, September 9.
UTLER (O. I.). — **Metadyne control.** (3 800 words ig.)

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938 621 .331
ctric Railway Traction, p. 477, Supplt. to the Railway Gazette, September 9.
he **metadyne system of control for D. C. traction ipments.** (1 000 words & fig.)

Railway Magazine. (London.)

938 656 .222.1 (.42)
ilway Magazine, No. 495, September, p. 163.
he **fastest trains** in Great Britain, 1938. (1 700 words tables.)

Railway Mechanical Engineer. (New York.)

938 621 .132.3 (.42)
ilway Mechanical Engineer, No. 8, August, p. 287.
Heavy **4-6-4 streamline locomotives.** (2 500 words ig.)

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938 62. (01 & 621 .43
lway Mechanical Engineer, No. 8, August, p. 293.
VILLIAMS (F. H.) — **Railway equipment service ures.** (1 200 words & fig.)

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938 625 .243 (.73) & 625 .245 (.73)
lway Mechanical Engineer, No. 8, August, p. 295.
angor & Aroostook **box cars.** (1 500 words & fig.)

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938 621 .43
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Les Chemins de fer et les Tramways, août-septembre, p. 133.

La prévention des accidents dans le **désherbage chimique.** (600 mots.)

L'Industrie des voies ferrées et des transports automobiles. (Paris.)

1938 **621 .114 & 621 .43**
L'Ind. des voies ferrées et des transp. autom., septembre, p. 252.

LEGRAND. — **Huiles de graissage** pour moteurs à explosion d'omnibus automobiles et d'automotrices légères. (7 700 mots.) (A suivre.)

L'Ossature métallique. (Bruxelles.)

1938 **656 .225 (4) & 656 .261 (.4)**
L'Ossature métallique, octobre, p. 407.

Le **transport par containers** en Europe. (5 000 mots. 2 tableaux & fig.)

1938 **624 .2**
L'Ossature métallique, octobre, p. 428.

JOUKOFF (A. S.). — Les bases expérimentales des calculs plastiques des **constructions hyperstatiques.** (3 200 mots & fig.)

Revue générale des chemins de fer. (Paris.)

1938 **385. (09 (.44) & 385 .11 (.44)**
Revue générale des chemins de fer, octobre, p. 139.

RIBOUD. — **L'exploitation des grands réseaux de chemins de fer français** de 1884 à 1937. (30 000 mots & fig.)

Revue universelle des Mines. (Liége.)

1938 **624 .2**
Revue universelle des mines, octobre, p. 731.

PIRARD (A.). — Simplification apportée dans l'étude des **treillis hyperstatiques** du premier degré par un emploi particulier du Williot. (5 800 mots & fig.)

Traction nouvelle. (Paris.)

1938 **621 .43 & 625**
Traction nouvelle, septembre-octobre, p. 138.

LEDARD (H.). — Les **relations accélérées par au rails** sur voie métrique. (3 500 mots, tableaux & fi

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1938 **621 .43 (.4**
Traction nouvelle, septembre-octobre, p. 146.

Le **programme des commandes d'autorails** de la Soci Nationale des Chemins de fer français. (2 200 mots fig.)

1938 **621 .43 (.42 + .6 + .9**
Traction nouvelle, septembre-octobre, p. 152.

REED (B.). — **Autorails** et traction Diesel dans l'E pire Britannique. (4 200 mots & fig.)

1938 **621 .43 (.4**
Traction nouvelle, septembre-octobre, p. 164.

FIOC. — L'intérêt national que présente le dével pement de la **traction Diesel.** (2 000 mots.)

1938 **625 .2**
Traction nouvelle, septembre-octobre, p. 167.

PEDELUCQ (J.). — Etudes en cours sur le **frein à grande vitesse.** (2 300 mots & fig.)

1938 **621 .132.8 (.498) & 621 .43 (.49**
Traction nouvelle, septembre-octobre, p. 173.

La **locomotive Diesel-électrique Sulzer** de 4 400 C. des Chemins de fer de l'Etat roumain. (1 000 mots fig.)

In German.

Die Reichsbahn. (Berlin.)

1938 **385. (09.3 (.**
Die Reichsbahn, Heft 38, 21. September, S. 912.

LOHSE. — Zur Jahrhundertfeier der Berlin-P damer Eisenbahn. (6 900 Wörter & Abb.)

1938 **656 .225 (.43) & 656 .235.7 (.**
Die Reichsbahn, Heft 39, 28. September, S. 931.

WENDT. — **Obst- und Gemüsebeförderung** bei Reichsbahn. (5 000 Wörter & Abb.)

1938 **385 .1 (**
Die Reichsbahn, Heft 40, 5. Oktober, S. 960.

BUSCH. — Das **formelle Finanzwesen** bei der D schen Reichsbahn im Spiegel des Wirtschaftlichkei lasses des Reichs- und Preussischen Wirtschaftsm sters. (5 200 Wörter.)

1938 **656 .231 (**
Die Reichsbahn, Heft 41, 12. Oktober, S. 979.

Tarifmassnahmen im Personen- und Güterver anlässlich der Wiedervereinigung der Ostmark mit Deutschen Reich. (6 300 Wörter.)

1938 **621 .139 (.43), 625 .18 (.43) & 625 .27 (.43)**
ie Reichsbahn, Heft 41, 12. Oktober, S. 985.
LORENZ. — Der **Abnahmedienst** der Deutschen
eichsbahn. (2 400 Wörter.)

1938 **625 .4 (.43)**
ie Reichsbahn, Heft 42, 19. Oktober, S. 1001.
WACHTEL (F.). — Rechtsfragen bei **Untergrund-ahnbauten** der Deutschen Reichsbahn. (10 000 Wörter.)

Elektrische Bahnen. (Berlin.)

1938 **621 .335 (.43)**
lektrische Bahnen, August, S. 179.
GANZENMÜLLER (A.) & RIEDMILLER (J.). — ntwicklung und Neuerungen in der **Erhaltung elek-rischer Triebfahrzeuge** bei der Deutschen Reichsbahn. 5 900 Wörter & Abb.)

1938 **621 .333**
lektrische Bahnen, August, S. 190; September, S. 207.
KOTHER (H.). — Die Auslegung des **Gleichstrom-ahnmotors.** (11 000 Wörter, 2 Tafeln & Abb.)

1938 **621 .337 (.43)**
lektrische Bahnen, August, S. 197.
BALKE (H.). — **Selbsttätige Schaltwerkssteuerung er C-Verschiebe-Lokomotiven** E 63.01-04 der Deutschen eichsbahn. (2 000 Wörter & Abb.)

1938 **62. (01**
lektrische Bahnen, September, S. 205.
MÜLLER (H. K.). — **Werkstückprüfung** mittels Ul-raschalls. (1 200 Wörter & Abb.)

1938 **621 .337**
lektrische Bahnen, September, S. 221.
KORNDÖRFER (H.). — Druckgasschalter für **elek-rische Lokomotiven.** (1 700 Wörter & Abb.)

1938 **621 .331 (.494)**
lektrische Bahnen, September, S. 224.
DANZ (A. E.). — Das **selbsttätige Gleichrichter-Un-erwerk** Alpnachstad der Pilatusbahn. (900 Wörter & bb.)

1938 **621 .33 (.47)**
lektrische Bahnen, September, S. 227.
Elektrischer Bahnbetrieb in Russland. (500 Wörter.)

Glasers Annalen. (Berlin.)

1938 **621 .13 (.43)**
lasers Annalen, Heft 19, 1. Oktober, S. 256.
BARTELS. — Der **maschinentechnische Betriebsdienst** er Reichsbahn unter besonderer Berücksichtigung der ugförderung mit Dampflokomotiven. (6 200 Wörter.)

1938 **381. (.43)**
lasers Annalen, Heft 19, 1. Oktober, S. 261.
BINDER (H.). — Der **Berliner S-Bahn-Betrieb;** ein onderzweig des Betriebsmaschinendienstes der Deut-chen Reichsbahn. (3 600 Wörter & Abb.)

1938 **625 .26**
Glasers Annalen, Heft 19, 1. Oktober, S. 267.
KAYSER (W.). — Der **Betriebswagendienst.** (5 200 Wörter & Abb.)

1938 **621 .332 (.43)**
Glasers Annalen, Heft 19, 1. Oktober, S. 272.
PREPENS. — Die **Stromversorgung** der Licht- und **Kraftanlagen** der Nordsüd-S-Bahn. (1 800 Wörter & Abb.)

1938 **385 .582 (.43)**
Glasers Annalen, Heft 19, 1. Oktober, S. 276.
MARTENS (A.). — **Unfallverhütung** im Betriebsma-chinendienst. (5 500 Wörter & Abb.)

Gleistechnik und Fahrbahnbau (Karlsruhe.).

1938 **625 .14 (01**
Gleistechnik und Fahrbahnbau, Heft Nr. 13/14, 15. Juli, S. 121; Heft Nr. 15/16, 15. August, S. 141.
VOGEL (R.). — Die **Berechnung** des **Querschwellen-Oberbaues.** (13 000 Wörter & Abb.)

1938 **625 .142.2 & 625 .142.3**
Gleistechnik und Fahrbahnbau, Heft 13/14, 15. Juli, S. 132.
LEONHARD. — **Stahl- oder Holzschwelle?** (5 000 Wörter.)

1938 **625 .14**
Gleistechnik und Fahrbahnbau, Heft Nr. 17/18, 15 September, S. 162.
PETRONI (E.). — Beitrag zur Frage der Unterlage-ziffer und der Druckverteilung in der **Gleisbettung.** (5 000 Wörter & Abb.)

1938 **625 .113**
Gleistechnik und Fahrbahnbau, Heft Nr. 17/18, 15. September, S. 170.
SCHRAMM (G.). — Das **Krümmungsbild** und seine Anwendung im Gleisbau. (1 600 Wörter & Abb.)

Organ für die Fortschritte des Eisenbahnwesens. (Berlin.)

1938 **621 .33 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 19, 1. Oktober, S. 351.
SCHUHMANN (H.). — Die **Elektrisierung** der Höllentalbahn. (5 400 Wörter & Abb.)

1938 **625 .14 (.43)**
Organ für die Fortschr. des Eisenbahnw., Heft 19, 1. Oktober, S. 358.
RELLENSMANN. — Zur Weiterentwicklung des **DWV-Gleitachslagers.** (3 000 Wörter, 3 Tafeln & Abb.)

1938 **625 .13 (.44)**
Organ für die Fortschr. des Eisenbahnw., Heft 19, 1. Oktober, S. 364.
WERNEKKE. — Die Eisenbahn St. Dié-Markirch und ihr **Vogesen-Tunnel.** (1 100 Wörter.)

1938 625 .1 (.44)
Organ für die Fortschr. des Eisenbahnw., Heft 19, 1. Oktober, S. 365.
Viergleisiger Ausbau einer französischen Eisenbahn. (600 Wörter & Abb.)

Zeitschrift des Vereines deutscher Ingenieure. (Berlin.)

1938 621 .392 & 669 .1
Zeitschr. des Ver. deutsch. Ing., Nr. 41, 8. Oktober, S. 1200.
CORNELIUS (H.). — Der Einfluss von Kohlenstoff und Mangan auf die **Schweissbarkeit von Stahl.** (1 800 Wörter & 2 Tafeln.)

1938 62. (01 & 665 .882
Zeitschr. des Ver. deutsch. Ing., Nr. 41, 8. Oktober, S. 1204.
LE COMTE (H.). — **Gefüge und Festigkeitseigenschaften** nachbehandelter Gasschmelzschweissen. (700 Wörter.)

1938 62. (01
Zeitschr. des Ver. deutsch. Ing., Nr. 41, 8. Oktober, S. 1206.
SPORKERT (K.). — Messgenauigkeit von **Härteprüfeindrücken.** (700 Wörter.)

Zeitschrift für das gesamte Eisenbahn-Sicherungs- und Fernmeldewesen. (Berlin.)

1938 656 .257
Zeitschr. für das Eisenb.-Sicherungs- und Fernmeldew., Nr. 13, 10. Oktober, S. 153.
REHSCHUH (G.). — **Fernsteuerung von Weichen und Signalen** mit Hilfe von Schrittschaltern. (3 000 Wörter & Abb.)

Zeitung des Vereins mitteleuropäischer Eisenbahnverwaltungen. (Berlin.)

1938 625 .14 (.43)
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 38, 22. September, S. 703.
KRAUSS (K.). — Die **Entwicklung der Oberbauformen** bei der Deutschen Reichsbahn. (3 200 Wörter & Abb.)

1938 385 .4 (.481)
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 38, 22. September, S. 715.
PASZKOWSKI. — Die **Organisation** der Norwegischen Staatsbahn. (1 800 Wörter.)

1938 385. (06.12
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 39, 29. September, S. 725.
Vereinsversammlung in Dresden am 14./16. September 1938. (15 000 Wörter.)

1938 656 .23. (0 (.43)
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 40, 6. Oktober, S. 743; Nr. 41, 13. Oktober, S. 763.
AHRENS (W.). — **Güterverkehr und Tarifpolitik** im rheinisch-westfälischen Wirtschaftsraum. (12 300 Wörter & Tafeln.)

1938 621 .392 & 625 .143
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 40, 6. Oktober, S. 751.
SCHNEIDER (Fr.). — Amerikanische Ansichten über das **Verhalten langer durchgehend geschweisster Schienen.** (4 300 Wörter & Abb.)

1938 385 (.485)
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 41, 13. Oktober, S. 771
PASZKOWSKI. — Die **Entwicklung** der schwedischen Privatbahnen im Jahre 1937. (1 400 Wörter.)

1938 385. (09 (.47)
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 41, 13. Oktober, S. 773.
FÜRBRINGER (G.). — Die **russischen Eisenbahnen** an der Schwelle des dritten Fünfjahresplanes. (2 700 Wörter.)

1938 385 .517.6
Zeitung des Ver. mitteleurop. Eisenbahnverw., Nr. 42, 20. Oktober, S. 789.
NIEDERSTADT. — **Bahnärztlicher Erfahrungsaustausch** im Verein Mitteleuropäischer Eisenbahnverwaltungen. (6 000 Wörter.)

In English.

Engineer. (London.)

1938 627 (.71) & 656 .213 (.71)
Engineer, No. 4314, September 16, p. 301.
LEGGET (R. F.). — **Some Canadian wharf structures of steel sheet piling.** (4 800 words & fig.)

1938 62. (06 (.42)
Engineer, No. 4314, September 16, p. 307.
The British Association. — Magnetic measurements. Vibration in ships and aircraft. (4 600 words.)

1938 624 .7 (.71 + .73)
Engineer, No. 4314, September 16, p. 315.
Thousand Islands bridges. (2 700 words & fig.)

1938 621 .
Engineer, No. 4314, September 16, p. 318.
A new method of metal spraying. (1 500 words & fig.)

1938 625 .4 (.42) & 725 .31 (.42)
Engineer, No. 4317, October 7, p. 380.
Moorgate joint station. (3 500 words & fig.).

1938 621 .3
Engineer, No. 4317, October 7, p. 396.
Ignition loading equipments for traction sub-station. (1 400 words & fig.)

1938 624 .32 (.73) & 624 .8 (.73)
Engineer, No. 4318, October 14, p. 406.
Marine Parkway bridge. (3 100 words & fig.)

1938 625 .232 (.42)
gineer, No. 4318, October 14, p. 420.
The new « Hook Continental » train. (900 words.)

Engineering. (London.)

1938 624 .32 (.42)
gineering, No. 3792, September 16, p. 342.
Jnit-construction footbridge over Western Avenue at eenford. (1 200 words & fig.)

1938 537 .7 & 62. (06 (.42)
gineering, No. 3792, September 16, p. 348.
ALL (D. C.). — Instruments for the measurement incremental permeability. (2 100 words & fig.)

1938 651 (.42) & 656 .212.6 (.42)
gineering, No. 3793, September 23, p. 353 and No. 3796, October 14, p. 437.
Iechanical equipment of the General Post Office, unt Plesant sorting office, London. (10 500 words &)

1938 385. (072 (.42)
gineering, No. 3793, September 23, p. 362.
he Sir Robert Hadfield metallurgical laboratories, ffield University. (2 000 words.)

938 624. (.71 + .73)
gineering, No. 3793, September 23, p. 377.
Iew International bridges, between Canada and the ted States. (1 900 words & fig.)

938 67
ineering, No. 3794, September 30, p. 391.
he metalastik system of bonding rubber and metal. 00 words & fig.)

938 656 .283 (.42)
ineering, No. 3794, September 30, p. 396.
he Charing Cross underground accident. (1 100 ds.)

938 721 .1
ineering, No. 3794, September 30, p. 403.
KEMPTON (A. W.). — Settlement analysis of engi-ring structures. (2 400 words & fig.)

938 621 .331
ineering, No. 3795, October 7, p. 428.
nition loading equipment for traction substations. 00 words & fig.)

938 621 .31
ineering, No. 3795, October 7, p. 431.
e adaptation of thermal power stations to work in unction with water power station. (2 100 words.)

938 536 & 621. (0
ineering, No. 3796, October 14, p. 451.
gh-pressure, high-temperature installations. (3 100 ls.)

1938 625 .232 (.42)
Engineering, No. 3796, October 14, p. 456.
New train for the L. N. E. R. London-Harwich service. (1 200 words.)

1938 016
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Documentation Congress at Oxford. (600 words.)

1938 385 .114 (.82) & 621 .43 (.82)
Engineering, No. 3796, October 14, p. 461.
Service results with diesel-electric railcars. (400 words.)

Engineering News-Record. (New York.)

1938 621 .392 (.73)
Engineering News-Record, No. 11, September 15, p. 325.
Structural welding advances under New York City code. (700 words & fig.)

1938 624. (.73)
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New hurricane bridge design. (8 200 ft. across Galveston Bay.) (900 words & fig.)

1938 624. (.73)
Engineering News-Record, No. 11, September 15, p. 329.
Viaduct built from barges. (1 800 words & fig.)

1938 721 .2 (.73)
Engineering News-Record, No. 11, September 15, p. 336.
WATERMAN (L. T.). — Retaining wall design charts. (700 words & fig.)

1938 624. (.73)
Engineering News-Record, No. 13, September 29, p. 399.
COHEN (A. B.). — Circular sheet steel piers support detour trestle. (1 700 words & fig.)

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1938 627. (.944
Journal, Institution of Engineers, Australia, No. 8, August, p. 279.
SPOONER (E. S.). — History and development of Port Kembla. (9 000 words & fig.)

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1938 656 .253 (.42)
London & North Eastern Railway Magazine, No. 10, October, p. 556.
A signalling innovation (the junction indicator). (800 words.)

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1938 621 .8 & 621 .9
Mechanical Engineering, No. 10, October, p. 729.
GRAVES (B. P.). — Motor drives and electric controls on machine tools. (4 200 words & fig.)

1938 621 .88
Mechanical Engineering, No. 10, October, p. 741.
MILLER (P. V.). — Recent developments in **thread-grinding practice.** (2 600 words.)

1938 62. (01
Mechanical Engineering, No. 10, October, p. 751.
SEKIGUCHI (Y.) and HASEGAWA (I.). — **A new smoothness tester.** (2 500 words & fig.)

1938 536
Mechanical Engineering, No. 10, October, p. 756.
KEENAN (J. H.). — The V. D. I. **steam tables.** (1 400 words & fig.)

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1938 385. (09 (.42)
Modern Transport, No. 1018, September 17, p. 3.
WOOD (Sir William). — A centenary review. **Influence of L. M. S. on trade and industrial development.** (2 800 words.)

1938 385. (064 (.42)
Modern Transport, No. 1018, September 17, p. 4.
Centenary Exhibition at Euston. Display of railway relics. (600 words.)

1938 385. (09 (.42)
Modern Transport, No. 1018, September 17, p. 5.
Centenary of London and Birmingham Railway. (3 200 words & fig.)

1938 385. (09 (.42)
Modern Transport, No. 1018, September 17, p. 9.
The Euston and Curzon Street termini. History of the stations. (2 000 words & fig.)

1938 385. (09 (.42)
Modern Transport, No. 1018, September 17, p. 10.
Features of London and Birmingham Railway. Tunnels, cuttings and earthworks. Original track and rolling stock. (2 000 words & fig.)

1938 656 .215 (.42)
Modern Transport, No. 1018, September 17, p. 12.
Improvement on railway stations. Importance of good lighting. (700 words & fig.)

1938 385. (09 (.42)
Modern Transport, No. 1018, September 17, p. 13.
Northampton and the railway. Why the London and Birmingham avoided the town. (1 500 words & fig.)

1938 656
Modern Transport, No. 1019, September 17, p. 23.
Development of road-rail transport, No. 4. — Requirements and systems. (1 800 words.)

1938 621 .33 (.68) & 656 .1 (.68)
Modern Transport, No. 1020, September 24, p. 3.
British built **trolleybuses** for Cape Town. (1 200 words & fig.)

1938 388. (.42
Modern Transport, No. 1020, September 24, p. 5.
Metropolitan line services to West End. Undergroun station amenities. (1 300 words & fig.)

1938 625 .156 (.43
Modern Transport, No. 1020, September 24, p. 6.
Signal innovation in Germany. Wheel counting m chanism. (500 words & fig.)

1938 656. (.68
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SIMMS (Edw.). — **Transport organisation** in Sou Africa. Advantages of unified administration. (2 0 words.)

1938 385 .1 (.42
Modern Transport, No. 1021, October 1, p. 2.
Modernising the Railways. (1 400 words.)

1938 623. (.42
Modern Transport, No. 1021, October 1, p. 3.
Transport services in event of war. (1 700 words fig.)

1938 385 .15 (.8
Modern Transport, No. 1021, October 1, p. 4.
Railways acquired in Argentina. (1 100 words.)

1938 385. (.43
Modern Transport, No. 1021, October 1, p. 5.
Railway problems of Czechoslovakia. Effects of p tition plan. (1 200 words & fig.)

1938 725 .31 (.4
Modern Transport, No. 1021, October 1, p. 6.
New methods in wayside station design. (1 500 wo & fig.)

1938 656 .2 (.4
Modern Transport, No. 1022, October 8, p. 3.
Freedom for road transport. Resolution at Birmi ham Conference. Problem of the rates structure. (2 words.)

1938 656 .2 (.4
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GUPWELL (L. W.). — **Rates structure for** ro **transport.** (2 600 words.)

1938 623. (.4
Modern Transport, No. 1022, October 8, p. 9.
Transport in national emergency. (2 000 words.)

1938 625 .232 (.4
Modern Transport, No. 1023, October 15, p. 3.
New train for L. N. E. R. continental service. (1 words & fig.)

1938 625 .144.4 (.
Modern Transport, No. 1023, October 15, p. 4.
Raising and moving railway track. (500 words & f

1938 **656 .213 (.42)**
odern Transport, No. 1024, October 15, p. 5.
Centenary of **Southampton docks.** — Southern Railay port enterprise story of progressive extension of uipment. (2 700 words & fig.)

1938 **656. (.42)**
odern Transport, No. 1024, October 15, p. 7.
SZLUMPER (G. S.). — Outlook for transport. **Railays and road competition.** (2 000 words.)

1938 **656 .222.1 (.42)**
odern Transport, No. 1024, October 15, p. 8.
WIENER (L.). — **European train speeds.** (1 200 ords.)

New Zealand Railways Magazine. (Wellington.)

1938 **621 .33 (.931)**
ew Zealand Railways Magazine, No. 5, August 1, p. 17.
Inauguration of the Wellington-Johnsonville electric ain service. (New Zealand.) (2 200 words & fig.)

1938 **621 .338 (.931)**
ew Zealand Railways Magazine, No. 5, August 1, p. 20.
Electric multiple-unit passenger coaches. (1 600 words fig.)

Railway Age. (New York.)

1938 **721 .31 (.73)**
ilway Age, No. 12, September 17, p. 401.
Colonial-type station embodies distinctive features. 500 words & fig.)

1938 **625 .23 (.42) & 656 .2 (.42)**
ilway Age, No. 12, September 17, p. 404.
HARTLEY (Sir Harold). — Amenities of railway ssenger travel. (3 300 words.)

1938 **656 .25 (.73)**
ilway Age, No. 12, September 17, p. 407.
PATTERSON (W. J.). — **The importance of rule 93.** fe yard operation dependent upon proper wording and rict observance of provisions. (3 000 words.)

1938 **656 .23 & 659**
ilway Age, No. 12, September 17, p. 409.
Superintendent's responsibility in public relations. 800 words.)

1938 **621 .132.3 (.73)**
ilway Age, No. 13, September 24, p. 428.
Milwaukee installs six **streamline passenger locomoes.** (3 800 words & fig.)

1938 **625 .232 (.73)**
ilway Age, No. 13, September 24, p. 435.
Milwaukee places **new passenger equipment in service.** 300 words & fig.)

1938 **624. (.73)**
ilway Age, No. 13, September 24, p. 443.
COHEN (A. B.). — **Flat-slab concrete bridges** embody usual features. (4 200 words & fig.)

1938 **656 .2 (.73)**
Railway Age, No. 13, September 24, p. 453.
Texas & Pacific intensifies **rail-highway co-ordination.** (1 400 words & fig.)

1938 **656 .284 (.73)**
Railway Age, No. 14, October 1, p. 471.
DICK (M. H.). — **New England roads ravaged** by floods and hurricane. (6 000 words & fig.)

1938 **625 .1 (06 (.73)**
Railway Age, No. 14, October 1, p. 478 and No. 15, October 8, p. 518.
Roadmasters hold constructive convention in Chicago. (10 800 words.)

1938 **621 .132.5 (.73)**
Railway Age, No. 14, October 1, p. 483.
Soo line locomotives built by Lima. (1 400 words & fig.)

1938 **621 .13 (06 (.73)**
Railway Age, No. 15, October 8, p. 512.
Locomotive supervisors hold live meeting. (6 800 words.)

Railway Engineering and Maintenance. (Chicago.)

1938 **624 .31 (.73)**
Railway Engineering and Maintenance, October, p. 604.
Preframed transfer bridges on the Baltimore and Ohio. (3 500 words & fig.)

1938 **614 .8**
Railway Engineering and Maintenance, October, p. 607.
How handle acetylene cylinders. (500 words.)

1938 **614 .8 & 624 .9**
Railway Engineering and Maintenance, October, p. 608.
Wood scaffolds — How to make them safe. (2 000 words & fig.)

Railway Gazette. (London.)

1938 **656 .259 (.42)**
Railway Gazette, No. 12, September 16, p. 489.
Mail apparatus warning plates. (400 words & fig.)

1938 **625 .14 (09 (.42)**
Railway Gazette, No. 12, September 16, p. 491.
Long-lived early permanent way. (400 words & fig.)

1938 **625 .232 (.485)**
Railway Gazette, No. 12, September 16, p. 492.
New all-steel sleeping cars. Swedish State Railways. (3 fig.)

1938 **625 .4 (.43)**
Railway Gazette, No. 13, September 23, p. 519.
The development of **aerial cableways** in Austria. (1 000 words & fig.)

1938 **621 .392 (.493) & 625 .143 (.493)**
Railway Gazette, No. 13, September 23, p. 522.
Re-use of worn rails, Belgian National Railways. (700 words.)

1938 **656 .1 (.485)**
Railway Gazette, No. 13, September 23, p. 529.
The road services of Sweden. (700 words & fig.)

1938 **625 .143.2 (.42)**
Railway Gazette, No. 14, September 30, p. 557.
Reproducing the wearing qualities of early steel rails under modern conditions. (5 000 words.)

1938 **385. (.437)**
Railway Gazette, No. 14, September 30, p. 563.
The Railways of Czechoslovakia. (1 300 words.)

1938 **725 .31 (.42)**
Railway Gazette, No. 14, September 30, p. 567.
New station at Apsley, L. M. S. R. (1 500 words & fig.)

1938 **625 .214**
Railway Gazette, No. 15, October 7, p. 605.
The Isothermos axlebox. (1 800 words & fig.)

1938 **656 .222.1 & 656 .25 (0**
Railway Gazette, No. 15, October 7, p. 607.
Speed in relation to signalling. (3 700 words.)

1938 **656 .254 (.945)**
Railway Gazette, No. 15, October 7, p. 611.
Traffic control on the suburban lines of the Victoria Railways. (800 words & fig.)

1938 **621 .9 (.42)**
Railway Gazette, No. 15, October 7, p. 614.
Machining locomotive details at Swindon Works — I. (200 words & fig.)

1938 **625 .235 (.42)**
Railway Gazette, No. 15, October 7, p. 614.
A hygienic lavatory cabinet. (200 words & fig.)

1938 **385. (091 (.56)**
Railway Gazette, No. 15, October 7, p. 620.
Railway development in Turkey. (400 words & 1 map.)

1938 **625 .232 (.42)**
Railway Gazette, No. 16, October 14, p. 641.
New rolling stock for the Hook Continental. (1 200 words & fig.)

1938 **625 .213 (.42)**
Railway Gazette, No. 16, October 14, p. 643.
The centenary of **Southampton docks.** (3 100 words & fig.)

1938 **656. (.42)**
Railway Gazette, No. 16, October 14, p. 656.
The past, present, and future of transport. (1 000 words.)

1938 **621 .43 (.82)**
Diesel Railway Traction, p. 580, Supplt. to the Railway Gazette, September 30.
Great diesel advance in Argentina. (1 700 words & fig.)

1938 **621 .43 (.42)**
Diesel Railway Traction, p. 583, Supplt. to the Railway Gazette, September 30.
English 1 000 b. h. p. high speed engine. (2 200 words & fig.)

1938 **621 .43 (.73)**
Diesel Railway Traction, p. 587, Supplt. to the Railway Gazette, September 30.
American **500 b. h. p. four-stroke engine** (Cummins) (700 words & fig.)

1938 **621 .43 (.42**
Diesel Railway Traction, p. 588, Supplt. to the Railwa Gazette, September 30.
A single-bank horizontal railcar engine. (500 word & fig.)

1938 **621 .43 (.73**
Diesel Railway Traction, p. 590, Supplt. to the Railwa Gazette, September 30.
Five-engined American **oil-electric shunting locomotiv of 700 b. h. p.** (900 words & fig.)

1938 **62. (01 (.44) & 621 .43 (.44**
Diesel Railway Traction, p. 592, Supplt. to the Railwa Gazette, September 30.
Railcar oil engine tests. (900 words.)

1938 **621 .331 (.42**
Electric Railway Traction, p. 664, Supplt. to the Railw Gazette, October 14.
Ignition loading equipments for traction substatio (1 700 words & fig.)

1938 **621 .336 (.49**
Electric Railway Traction, p. 666, Suppl. to the Railw Gazette, October 14.
MESSER (M.). — The maintenance of **contact li supports.** (1 400 words & fig.)

1938 **621 .338 (.4**
Electric Railway Traction, p. 669, Supplt. to the Railwa Gazette, October 14.
Rubber-tyred electric train. (500 words & fig.)

Railway Magazine. (London.)

1938 **621 .13**
Railway Magazine, No. 496, October, p. 237.
The tractive effort of steam locomotives. (1 words.)

1938 **656 .222.1 (.4**
Railway Magazine, No. 496, October, p. 243.
ALLEN (C. J.). — **British locomotive practice a performance.** (4 800 words & fig.)

1938 385. (09 (.42)
lway Magazine. No. 496, October, p. 255.
EE (Ch. E.). — **The London and Birmingham Rail-y — I.** (5 500 words & fig.)

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938 656 .222.1 (.4)
lway Magazine, No. 496, October, p. 284.
uropean express trains in the summer of 1938 — I. 00 words.)

Railway Mechanical Engineer. (New York.)

938 621 .132.3 (.73) & 621 .132.5 (.73)
lway Mechanical Engineer, October, p. 361.
-8-4 type locomotives. (1 400 words & fig.)

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938 62. (01 & 621 .135.2
lway Mechanical Engineer, October, p. 365.
ocomotive axle testing. (4 500 words & fig.)

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938 625 .232 (.73)
lway Mechanical Engineer, October, p. 372.
ightweight Pullman sleeping cars. (2 100 words &)

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938 62. (01 & 621 .134.2
lway Mechanical Engineer, October, p. 377.
VILLIAMS (F. H.). — **Combination lever service ures.** (1 300 words & fig.)

Railway Signaling. (Chicago.)

938 656 .254 (.73) & 656 .235 (.73)
way Signaling, October, p. 569.
entralized traffic control on the Missouri Pacific. 00 words & fig.)

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938 656 .254 (.73) & 656 .283 (.73)
way Signaling, October, p. 573.
ccident involving signals and train stop system. 00 words & fig.)

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938 656 .258 (.73)
way Signaling, October, p. 575.
utomatic interlocking on the Frisco. (2 200 words ig.)

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938 625 .162 (.73) & 656 .259 (.73)
way Signaling, October, p. 578.
utomatic crossing gates on the Rock Island. (2 400 ls & fig.)

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938 656 .258
way Signaling, October, p. 582.
eleases for automatic interlockings. (1 700 words.)

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th African Railways and Harbours Magazine. (Johannesburg.)

938 385. (092 (.485)
h African Railways & Harbours Magazine, September, p. 1169.
e State Railways of Sweden. (1 500 words & fig.)

The Locomotive. (London.)

1938 385. (093 (.42)
The Locomotive, No. 554, October 15, p. 302.
BARRIE (D.S.). — **The London & Birmingham Railway.** (1 900 words & fig.)

1938 621 .132.3 (.42) & 656 .222.1 (.42)
The Locomotive, No. 554, October 15, p. 305.
Coloured supplement, L. N. E. R. 4-6-2 locomotive, No. 4468 « Mallard ». (900 words.)

1938 621 .132.3 (.52) & 625 .232 (.52)
The Locomotive, No. 554, October 15, p. 310.
Chosen Railway, Corea — Prairie type locomotives and combined mail and passenger car. (1 200 words & fig.)

1938 621 .43 (.489)
The Locomotive, No. 554, October 15, p. 315.
ABEL (E.). — **Railcars and diesel-electric trains.** (1 700 words & fig.)

1938 625 .212 & 625 .22
The Locomotive, No. 554, October 15, p. 330.
The **free wheel** on railway vehicles. (1 800 words & fig.)

The Oil Engine. (London.)

1938 621 .43 (0
The Oil Engine, No. 66, Mid October, p. 169.
Diesel engine for emergencies, A. R. P., peak loads and stand by services. (2 300 words.)

1938 621 .43 (.44) & 625 .23 (.44)
The Oil Engine, No. 66, Mid October, p. 173.
A « two storey » Diesel-engined railcar now being built in France. (3 figures.)

1938 621 .43
The Oil Engine, No. 66, Mid October, p. 188.
Safety in operation (Practice of engine makers with regard to overspeed governors, water and oil-pressure safeguards). (2 100 words & fig.)

1938 621 .43 (.43)
The Oil Engine, No. 66, Mid October, p. 190.
Transmission efficiency with diesel-electric traction. (300 words & fig.)

1938 621 .43
The Oil Engine, No. 66, Mid October, p. 192.
A Roots-type supercharger for oil engines. (700 words & fig.)

1938 621 .43 (.73)
The Oil Engine, No. 66, Mid October, p. 196.
MANN (Ch. F. A.). — **Latest American Diesel trains.** (700 words & fig.)

Transit Journal. (New York.)

1938 **388. (.73)**
Transit Journal, No. 10, September 26, p. 333.

The 1938 Convention in print. (A series of articles on **transit problems and modern equipment.**)

University of Illinois Bulletin. (Urbana.)

1938 **526**
University of Illinois Bulletin, No. 75, May 17.

RAYNER (W. H.). — **Two investigations on transit instruments.** (6 000 words & fig.)

1938 **625 .7 (06 (.73)**
University of Illinois Bulletin, No. 77, May 24.

Conference on **highway engineering** — 1938 (162 pp.)

1938 **625 .143.3 (.73)**
University of Illinois Bulletin, No. 93, July 19.

MOORE (H. F.). — Fourth progress report of the joint investigation of **fissures in railroad rails.** (52 pp. Illustrated.)

In Italian.

La tecnica professionale. (Firenze.)

1938 **62. (01**
La tecnica professionale, ottobre, p. 223.

I raggi X e loro applicazioni industriali. (2 000 parole & fig.)

1938 **621 .83**
La tecnica professionale, ottobre, p. 229.

PISTOCCHI (A.). — Contributo alla conoscenza delle **dentature.** (4 600 parole & fig.)

L'Ingegnere. (Roma.)

1938 **693**
L'Ingegnere, ottobre, p. 662.

CONSIGLIO (A.). — La **stabilitá dei rivestimenti lapidei** in lastre. (2 200 parole & fig.)

1938 **621 .332**
L'Ingegnere, ottobre, p. 665.

REBORA (G.). — **Effetto « Corona ».** (1 200 parole & fig.)

1938 **621 .132.8**
L'Ingegnere, ottobre, p. 667.

CROSTI (P.). — **Nuove locomotive** per ferrovie coloniali. (1 500 parole & fig.)

1938 **693**
L'Ingegnere, ottobre, p. 670.

CESTELLI GUIDI (C.). — Razionale composizione dei **conglomerati cementizi.** (2 500 parole & fig.)

Rivista tecnica delle ferrovie italiane. (Roma.)

1938 **621 .33 (.45) & 656 .222.1 (.45)**
Rivista tecnica delle ferrovie italiane, 15 settembre, p. 137.

L'elettrotreno alla velocitá commerciale di 155 km./ora sui 214 km. della Roma-Napoli. (600 parole & fig.)

1938 **625 .244 (.45)**
Rivista tecnica delle ferrovie italiane, 15 settembre, p. 140.

DEL GUERRA (G.). — **Nuovi carri refrigeranti** delle Ferrovie Italiane dello Stato. (2 800 parole & fig.)

1938 **621 .331 (.43)**
Rivista tecnica delle ferrovie italiane, 15 settembre, p. 148.

CAVALLINI (G.). — Le gru nelle **sottostazioni di conversione a corrente continua** a 3 kV. (7 000 parole & fig.)

1938 **656 .211 (.45**
Rivista tecnica delle ferrovie italiane, 15 settembre, p. 180.

NARDUCCI (R.). — **I nuovi fabbricati delle stazioni** di Loano ed Albenga. (800 parole & fig.)

Trasporti e lavori pubblici. (Roma.)

1938 **625 .21**
Trasporti e lavori pubblici, settembre, p. 269.

L'invenzione di una rotaia con terminale a sezione variabile per sopprimere gli urti nei punti di giunzio[illegible] (1 000 parole & fig.)

1938 **621 .335 (.4**
Trasporti e lavori pubblici, settembre, p. 277.

Automotrici e rimorchiate-pilota a corrente contin[illegible] 3 000 volt per la Ferrovia Bologna-Vignola. (700 par[illegible] & fig.)

In Dutch.

De Ingenieur. (Den Haag.)

1938 **62. (01 & 6**
De Ingenieur, Nr 40, 7 October, p. Bt. 67.

Toepassing van hooge spanningen bij **gewapend-bet[illegible] constructies.** (5 400 woorden & 2 tabellen.)

1938 **385 .587 (.**
De Ingenieur, Nr 41, 14 October, p. V. 59.

TIMMERS VERHOEVEN (S. G.). — De in de [illegible]trale werkplaats van de Nederlandsch-Indische Sp[illegible] weg-Maatschappij te Djokjakarta in toepassing zij[illegible] **bandwerkwijzen.** (11 000 woorden & fig.)

1938 **624 .63 (.4**
De Ingenieur, Nr 42, 21 October, p. B. 199.

Het **ongeval met de brug** over het Albert-kanaal [illegible] Hasselt. (2 400 woorden & fig.)

Spoor- en Tramwegen. (Utrecht.)

1938 **385. (09.2**
Spoor- en Tramwegen, Nr 21, 11 October, p. 527.
VAN DER MEULEN (G.). — **Bij het aftreden van Mr. H. van Manen.** (1 600 woorden.)

1938 **623 (.4)**
Spoor- en Tramwegen, Nr 21, 11 October, p. 532.
ERKENS (J.). — **De spoorwegen in den wereldoorlog.** (2 000 woorden & fig.)

1938 **621 .13 (09 (.492)**
Spoor- en Tramwegen, Nr 21, 11 October, p. 535.
LABRIJN (P.). — **De Staatsspoor-locomotieven van vóór 1880.** (1 000 woorden & fig.)

In Rumanian.

(= 599)

Revista tecnica C. F. R. (Bucuresti.)

1938 **621 .132.3 (.498) = 599**
Revista C. F. R., May-June, p. 119.
PETRESCU (S.). — **Caracteristic defects,** revealed **in service, of the Rumanian Pacific type locomotive.** (9 000 words & fig.)

In Polish.

(= 91.885)

Inżynier Kolejowy. (Warszawa.)

1938 **625 .113 = 91 .885**
Inzynier Kolejowy, No. 10, p. 412.
LENKOWSKI (G.). — **Curve alignment** by measurement of the versines. (2 400 words & 2 tables.)

1938 **656 .21 = 91 .885**
Inzynier Kolejowy, No. 10, p. 416.
GROBICKI (W.). — **Layout of railway lines giving access to the centres to be served,** and selection of the type and site of the stations. (4 900 words & fig.)

In Portuguese.

Revista das estradas de ferro. (Rio de Janeiro.)

1938 **656**
Revista das Estradas de ferro, nº 317, 30 de setembro, p. 2109.
Coordenação de transportes. (2 900 palavras.)

M. Weissenbruch Co., Ltd., Printer of the King, 49, rue du Poinçon, Bruxelles.

NALYTICAL TABLE OF ARTICLES

ARRANGED ACCORDING TO THE DECIMAL CLASSIFICATION

(1938)

Month.

385. (093. History of railways.

Histoire des Chemins de fer Yougoslaves (*History of the Jugoslavian Railways* [1825-1937]), by D. ARNAOUTOVITCH. (*New book.*) . . . . February.

385 .1. Railways from a financial point of view. Their effect on a country's finances.

Mesures de rationalisation et d'économie prises par les Chemins de fer fédéraux suisses depuis 1920, et leurs effets financiers (*Rationalisation and economic measures taken by the Federal Railways since 1920, and the financial results thereof*). — Published by the GENERAL MANAGEMENT OF THE SWISS FEDERAL RAILWAYS. (*New book.*) . . . . »

385 .15. Railways worked by the State or by Companies, from an economic and financial point of view. State railway purchase.

Nationalisation of Transport. (*Book review.*) . . . . December.

385 .3. State control over railways.

385 .3(08. Reports.

Annual Report of the Interstate Commerce Commission (1-11-36 to 31-10-37) . August.

385 .5. Staff.

385 .57. Recruting and promotion of staff.

Selection, orientation and instruction of railway staff (Subject XI, 13th Congress) (*Discussion*) . . . . June.

6. Useful Arts.

62. Engineering.

62. (01. Strength of materials. Physical tests.

Finding weak spots in bridges, by Rudolf K. BERNHARD . . . . January.
The effect on locomotive boilers of pitting and corrosion, by L. C. CALLAHAN . March.
The Fourth Rail Congress (Dusseldorf, 1938) . . . . December.

621. Mechanical and electrical engineering.

621 .1. Steam engineering.

621 .13. Locomotive engines.

Recent improvements in steam locomotives of the usual type and tests of new designs (high-pressure reciprocating locomotives and turbine locomotives) as regards construction, quality of materials used, efficiency, working conditions, maintenance and financial results. — Testing locomotives at experimental stations, and in service with dynamometer cars and brake locomotives (Subject V, 13th Congress). — Discussion . . . . February.

Der Dampfbetrieb der Schweizerischen Eisenbahnen (Steam traction on the Swiss Railways), by A. MOSER. (*New book.*) . . . . December.

621 .13. (02. Handbooks, treatises, etc.

Elsners Taschenbuch für den Werkstätten und Betriebs-Maschienendienst bei der Deutschen Reichsbahn (*Elsner's Handbook for the locomotive and rolling stock department and repair shops of the German State Railways*). (*New book.*) . . . . June.

Leitfaden für den Dampflokomotivdienst (*Manual for the steam locomotive staff*), 1938, 2nd edition, by L. NIEDERSTRASSER. (*New book.*) . . . . . . December

	Month.
621 .134. The steam engine.	
621 .134.1. Driving mechanism (motion).	
Welded cylinders for 2-8-2 locomotives, French National Railways Company, by E. MONIER	August.
621 .134.2. Steam distribution. Valve gear.	
A new apparatus for controlling the distribution of steam in the cylinders of a locomotive, by Florian SERBESCO	July.
An interesting locomotive valve-setting machine	August.
621 .135. Vehicle of the locomotive.	
621 .135 (01. Stability of the locomotive when running. Weight distribution. Counter-balance weights, etc.	
Method of registering slight displacements. Results of some measurements, by Mr. BANCELIN	December.
621 .135.2. Wheels. Axles. Axle boxes. Lubrication of journals, etc...	
Methods of investigating cracks in axles, by Mr. CONTE	»
621 .135.4. Running over curves. Bogies. Bissel trucks.	
Graphical method of determining the frictional and guiding forces on railway vehicles running through curves, by Dr.-Ing. TROITZSCH	August.
Memorandum on the running of railway vehicles on curves, by F. LEGEIN . .	September.
621 .137. Locomotive working.	
621 .137 (02. Manuals, handbooks, etc.	
Leitfaden für den Dampflokomotivdienst (Manual for the steam locomotive staff), 2nd Edition, by L. NIEDERSTRASSER. (*New book.*)	December.
621 .138. Laying up and maintaining the locomotives.	
621 .138.5. Repairing locomotives. Repair shops.	
Methods used on the Canadian National Railways for the maintenance of diesel engines, by I. I. SYLVESTER	July.
621 .138.5 (02. Manuals, handbooks, etc.	
Elsners Taschenbuch für den Werkstätten und Betriebs-Maschienendienst bei der Deutschen Reichsbahn (*Elsner's Handbook for the locomotive and rolling stock department and repair shops of the German State Railways*) (*New book.*)	June.
621 .3. Electrical engineering.	
621 .33. Electric railways and tramways. Railway electrification.	
Methods and devices used, in connection with electric traction, to save current between the supply side of the power station and the driving wheels (feeders, substations, tractors), and in particular the use of mercury rectifiers. (Subject VI, 13th Congress.) — Discussion	February.
Electrification of the Paris-Le Mans line of the former French State Railways, by J. DUMAS	November.
621 .335. Electric locomotives, electric motor coaches.	
The Breda 900-H.P. electric streamline trains	July.
Main-line oil-electric locomotive for Roumania	December.
621 .337. Control devices.	
Electric train control. — The metadyne system	January.

Month.

625 .234. Heading and ventilation. Air conditioning.

Air conditioning in railway vehicles, by Mr. PLA . . . . August.

625 .24. Goods wagons.

625 .245. Special wagons.

Improvements in the construction of tank wagons, by Hans RICHTER . . . . January.

625 .25. Brakes.

625 .252. Parts common to all brakes : shoes, rigging, etc.

The new F. S. (Italian State Rys.) device for varying the brake gear ratio, by R. MARIANI and M. FASOLI . . . . July.

625 .253. Compressed-air brake.

Air brake accelerators. Single accelerators and coupled accelerators, by Dr. Ernst MÖLLER . . . . March.

625 .26. Carriage and wagon repair shops.

625 .26 (02. Handbooks, manuals, etc.

Elsners Taschenbuch für den Werkstätten und Betriebs-Maschienendienst bei der Deutschen Reichsbahn (*Elsner's Handbook for the locomotive and rolling stock department and repair shops of the German State Railways*). (*New book*.). . June.

625 .6. Light railways. Tramways, etc.

625 .61. Light-railway engineering. Narrow-gauge lines.

625 .61 (01. General matters. Utility (feeder lines and lines competing with main lines).

Co-ordination of operation as between main-line and light railways (Subject XII, 13th Congress) — (*Discussion*) . . . . »

625 .611. Construction and operation of light railways.

Specifications for the fixed plant of railways with light traffic, intended to prevent the use of unnecessarily expensive track equipment, and generally to give economical working (Subject XIII, 13th Congress) — (*Discussion*) . . .

656. Transport by road, rail, etc.

Competition by road, waterways and airways (*continued*) : Great Britain (1937) March.

France, Algeria, British India . . . . October.

Comparative study of motor transport regulations (6th Article), by Vladimir IBL April.

Effects of the world crisis and road competition on the railway position. Corresponding changes in railway commercial policy. (Subject X, 13th Congress) — (*Discussion*) . . . . June.

La Concorrenza fra la strada e la rotaia nella politica economica dei Trasporti (*Competition between road and rail in the transport economic policy*), by Prof. Renato TREVISANI. (*New book*.) . . . . August.

Nationalisation of Transport. (*Book review*.) . . . . December

656 .2. Carriage by railway. Railway working.

656 .2 (02. Treatises, handbooks, etc.

Cours d'exploitation des chemins de fer. Tome III : Pose de la voie en courbe (*Railway operating course*. Vol. III : *Track laying on curves*), 2nd edition, by U. LAMALLE. (*New book*.) . . . . September.

	Month.
656 .25. Safety precautions. Signals.	
Cours d'exploitation des Chemins de fer. Tome II : Exploitation technique. Signalisation. (*Railway operating course. Vol. II. Technical operation. Signalling*), 2nd Edition, by U. LAMALLE). (*New book.*)	November.
Transfer of signal box No. III at Brussels (Nord) Station, by C. L.	December
656 .253. Fixed road and station signals.	
The use of luminescent tubes to supplement signals in tunnels, by R. LEVI .	»
656 .254. Apparatus for communicating information at long distances. Alarm bells and special warning devices. Telegraph. Telephone. Communication between stations and trains in motion. Various systems of working. Train dispatchers. Automatic train control.	
Results obtained from the automatic and distant operation of signals and points and from locomotive cab signals (Subject IX, 13th Congress) — (*Discussion*) .	April.
The « Parisienne-Metrum » (P.A.M.) system of cab signalling	December
656 .258. Interlocking installations.	
New York Central installs first button-control route interlocking	February.
656 .259. Various safety devices.	
Floodlights at highway crossing. Installation on Missouri-Kansas-Texas supplements flashing-light signals	April.
Efficiency of crossing protection, by Warren HENRY	October.
656 .27. Working of main-line branches carrying little traffic, and of light railways.	
Economical operation of the main line systems' secondary lines. Various methods adopted to adjust the operating facilities, safety measures and station organisation to the volume of traffic (Subject VII, 13th Congress) — (*Discussion*).	April.
Specifications for the fixed plant of railways with light traffic, intended to prevent the use of unnecessarily expensive track equipment, and generally to give economical working (Subject XIII, 13th Congress) — (*Discussion*) . .	June.

659. Advertising and other topics.

Facts about British Railways (1938). (*Review.*)	July.

66. Chemical industry.

662. Fuels, explosives, etc.

La technique de l'Industrie des pétroles (*The technique of the oil industry*). Special issue of « Science et Industrie ». (*Review.*)	September.

69. Building.

The « Joosten » process of consolidating and sealing permeable soil, by Dr. A. KARSTEN	June.

698. Painting, glazing, etc.

Paint research on the London Midland and Scottish Railway	December

XX — Nº 12

DECEMBER 1938

Monthly Bulletin of the International ailway Congress Association

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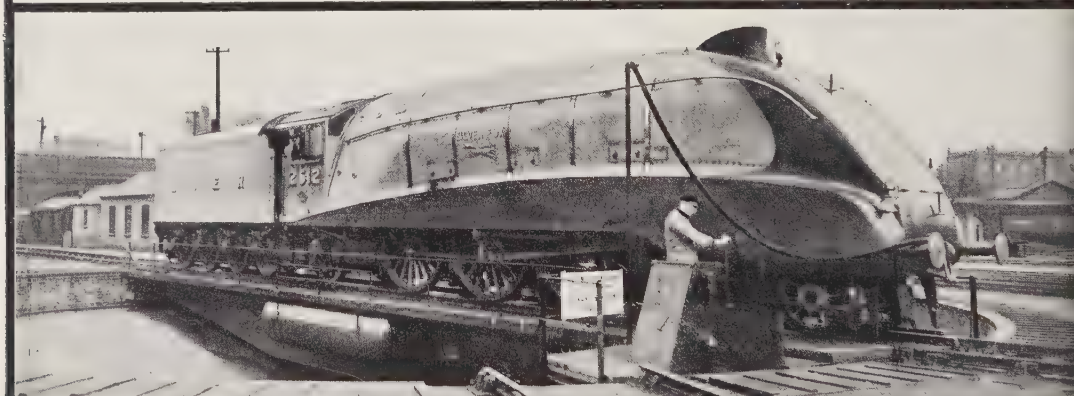

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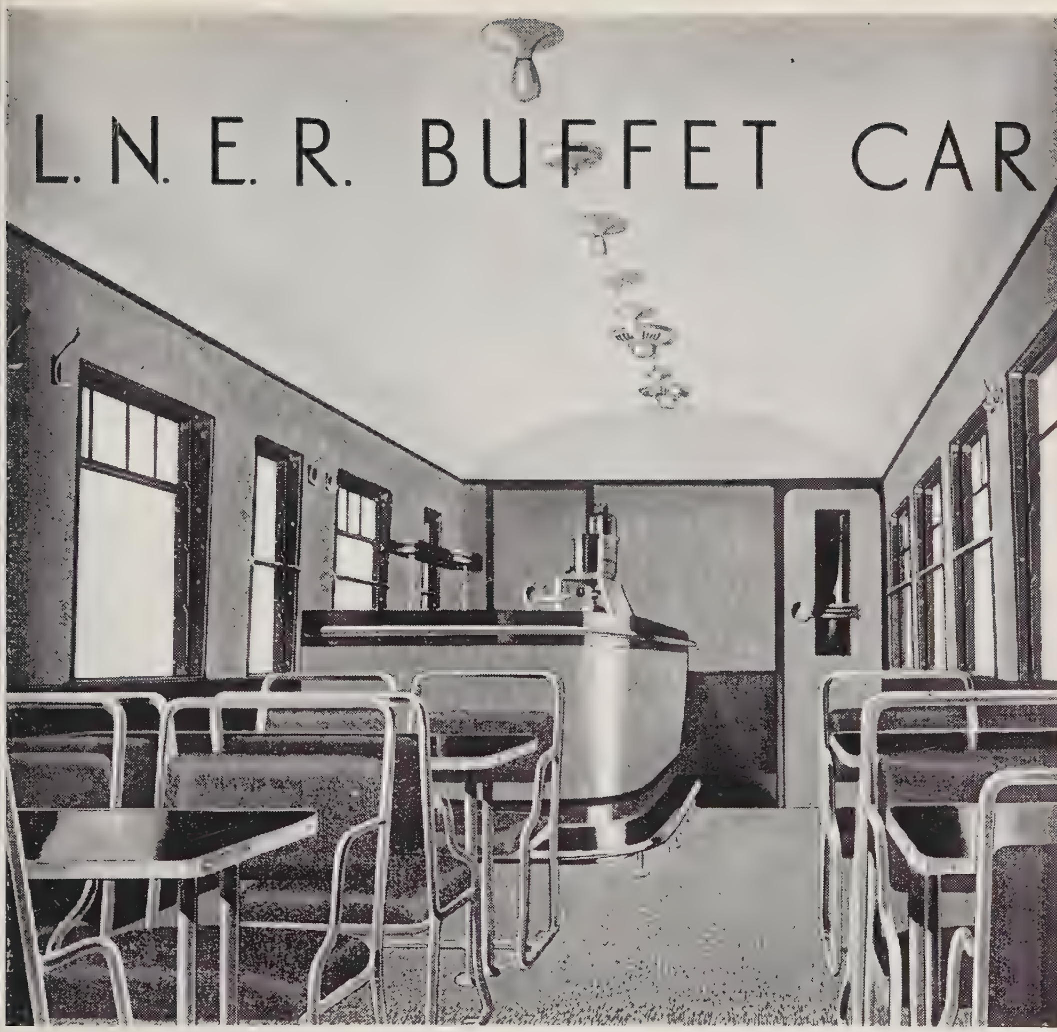
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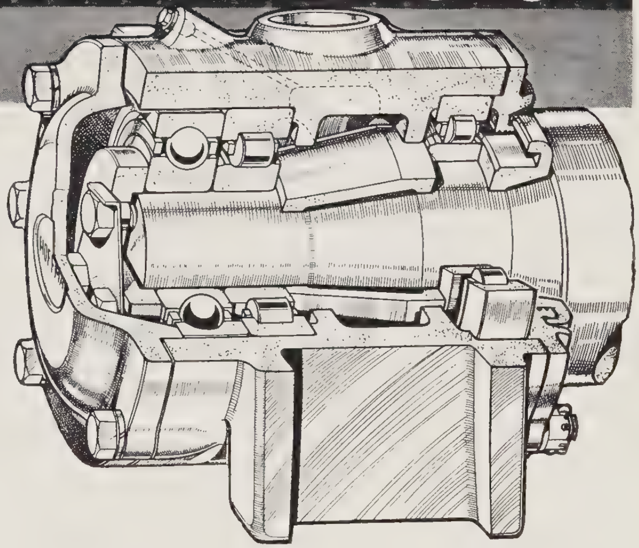
Spain : Rudolfo Schmitz, Apartado 494, **Bilbao.**
Switzerland : Ing. H. Versell, **Wallisellen-Zürich,** Eigenheimstr. 6.
German-Austria : Obering. J. Kroschel, **Wien IV,** Brucknerstr. 6.

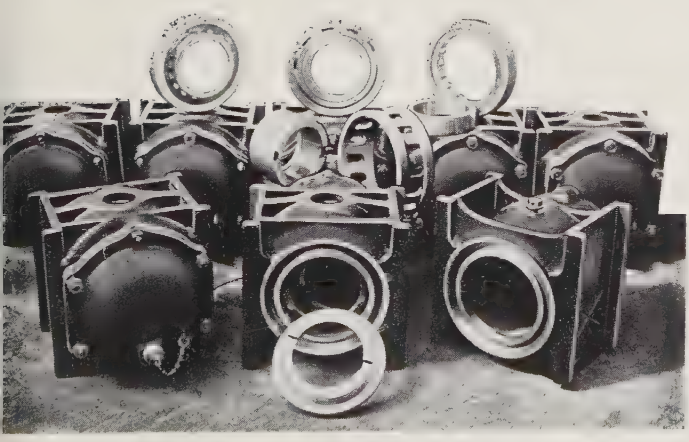


These figures present the case for the

HOFFMANN

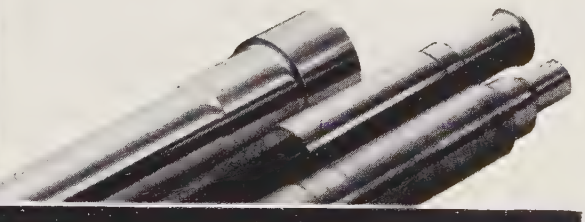
ROLLER BEARING AXLE BOX

Engine Number	*Mileage on Oct. 5*
6208	252,231
6209	266,658
6210	235,983
6211	228,744
6212	242,465

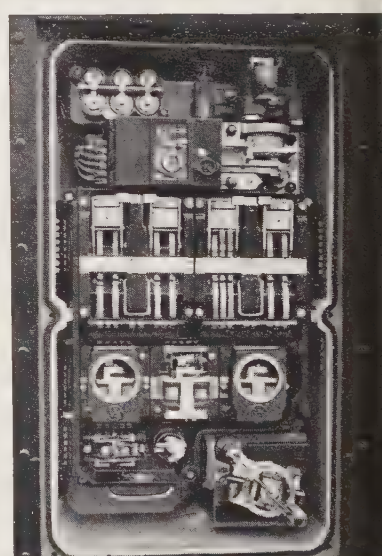


The Hoffmann Boxes, fitted to the trailing axles of each locomotive, have given absolutely trouble-free service and are still piling up the miles. Hoffmann Needle Roller Bearings are also fitted to the Valve Link motions of each locomotive.

THE HOFFMANN Mfg. Co. Ltd.
CHELMSFORD ESSEX



For Automatic Train Control on the Inductive System —



Knorr Compressed air equipment

The apparatus case on the outside of the driver's cab contains also the Knorr compressed air equipment comprising time-switch, centrifugal speed-checking device, and vigilance, free-handle, permissive, recording and emergency valves. This equipment applies impulses transmitted inductively from the track apparatus to the operation of the compressed air brakes. Automatic braking is applied, if the driver has neglected to press the vigilance button or has not reduced the speed to a prescribed extent, preparing to stop the train at the home signal.

KNORR-BREMSE A-G BERLIN

Bulletin of the International Railway Congress Association

CONTENTS OF THE NUMBER FOR DECEMBER 1938.

Alphabetical Index of Advertisers

Firms:		Specialities:
Spencer-Moulton & Co., Ltd. (George) .	XXIX	India rubber springs of all kinds.
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United Steel Companies, Ltd. (The) . .	—	Steel sleepers, steel for all purposes.
Vacuum Brake Co., Ltd.	—	Air brakes.
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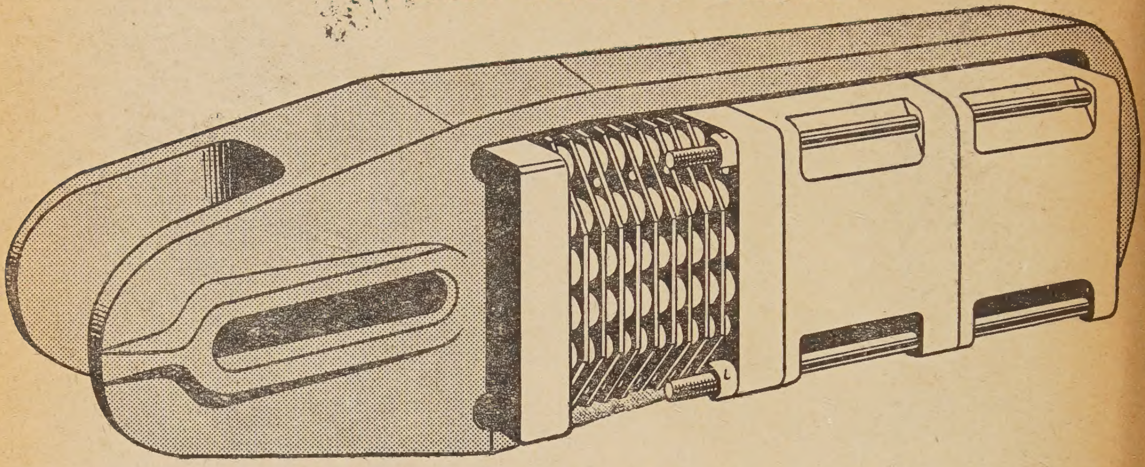

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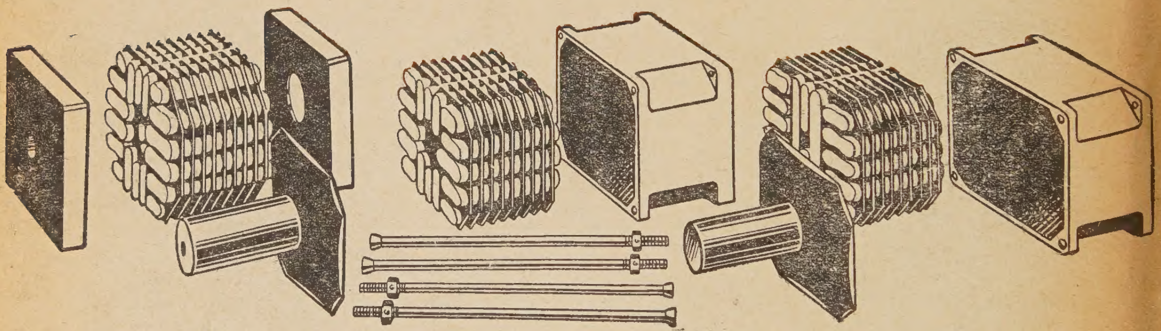

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